Untangling the Organizational Ambiguities in Supply Chain Risk Recognition, Assessment, and Response: The Role of Network Embeddedness

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Abstract

In this thesis, I focus on supply chain risk related ambiguity, which represents the ambiguities firms exhibit in recognizing, assessing, and responding to supply chain disruptions. I, primarily, argue that ambiguities associated with recognizing and responding to supply chain risk are information gathering and processing problems. Guided by the theoretical perspective of bounded rationality, I propose a typology of supply chain risk related ambiguity with four distinct dimensions. I, also, argue that the major contributor to risk related ambiguity is often the environment, specifically the web of suppliers. Hence, I focus on the characteristics of these supplier networks to examine the sources of ambiguity. I define three distinct elements of network embeddedness – relational, structural, and positional embeddedness – and argue that the ambiguity faced by a firm in appropriately identifying the nature or impacts of major disruptions is a function of these network properties.

Based on a survey of large North American manufacturing firms, I found that the extent of the relational ties a firm has and its position in the network are significantly related to supply chain risk related ambiguity. However, this study did not provide any significant support for the hypothesized relationship between structural embeddedness and ambiguity. My research contributes towards the study of supply chain disruptions by using the idea of bounded rationality to understand supply chain risk related ambiguity and by providing evidence that the structure of supply chain networks influences the organizational understanding of and responses to supply chain disruptions.

Keywords: bounded rationality, ambiguity, supply chain networks, supply chain risk, supply chain disruption.

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1. Introduction

Supply chains have become increasingly critical for the operational and strategic performance of firms; hence, the failures or disruptions that affect the functioning of the chain can have far reaching consequences for firms. The increased focus on generating supply chain efficiencies through practices such as lean production, vendor managed inventory, and just-in-time operations, combined with the increasing complexity of globalized supply chains and outsourcing initiatives, has greatly increased the vulnerability of supply chains to disruptions. The negative consequences of supply chain failures can have devastating effects not only on the financial and non-financial performance of firms, but also on their viability and long term survival. The announcement of supply chain glitches, on average, decreases shareholder value by 10.28% in the short run (Hendricks and Singhal, 2003) and, over a longer period of time, the returns on a firm’s stock can decrease by as much as 40% below normal, which has a prolonged negative effect on the firm (Hendricks and Singhal, 2005). Further critical adverse effects, such as a major drop in operating income and a declining return on sales and assets have been reported in multiple studies on the effects of supply chain disruptions on organizations (Chopra and Sodhi, 2004; Pearson, 2012; Wagner and Bode, 2008).

While the impact of major disruptions on supply chains and the subsequent negative economic consequences for the firms have been widely reported and discussed in the industry and academia (Hendricks and Singhal 2003; Hendricks and Singhal, 2005; Tang, 2006a; Tang and Tomlin, 2008), a topic that has received relatively less attention is the significant ambiguity and uncertainty that firms exhibit in their ability to recognize the incidences and outcomes of major supply chain disruptions. Firms are often shown to be highly ambiguous and equivocal in their ability to identify the exact nature, dimensions, effects, and outcomes of major supply chain risk events. Such uncertainties and ambiguities are exhibited throughout the lifecycle of a disruptive event, including the event's onset, incidence, and conclusion. In addition to the ambiguities associated with recognizing the manifestation and impacts of supply chain disruptions and risk, firms have also been found to be particularly unclear in terms of response strategies and the effectiveness of those strategies in the event of major disruptions.

It is important to note in this respect that not all disruptive events are due to natural calamities such as earthquakes or floods, which can be unannounced and hard to read, gauge, or manage once the disruption strikes. Practitioner experiences actually show that a significant proportion of major supply chain disruptions are associated with what can be broadly described as operational, planning, technological, or design-related failures, wherein executives have good insight and information into the relevant causes and incidences tied to the failure yet fail to appropriately gauge and respond to those disruptive events once they unfold. One recent survey indicates that by far the biggest contributor to supply chain disruptions, close to 55% of all incidents, was IT or telecom failures, followed by adverse weather, outsourcing service failures, talent/human resource related issues, and transportation network failure, in that order (Zurich Supply Chain Survey, 2013). Barring adverse weather, all major causes of supply chain failures are operations or planning related failures. The distinction between natural and what can be termed as operational or organizationally rooted causes of supply chain failure has been recognized by a few scholars, where-in a supplier defaulting due to financial issues has been argued to be materially different from supply chain disruptions due to an earthquake (Wagner and Bode, 2008). In this context, many have called for a better examination of the organizational decision-making processes involved in dealing with supply chain disruptions (Hult et al., 2010; Craighead et al., 2007).

Multiple practitioner examples highlight the supply chain risk recognition ambiguity exhibited by firms, capturing the ambiguities and uncertainties involved in appropriately identifying the nature, scale, relevance, or impacts and risk posed by major disruptive supply chains events. Toyota, for example, was aware as early as 2002 of the constant quality issues with its supplier components which led to recall of 7.5 million cars for the brake pedal issue in 2009, and led to significant production, market share, and brand value losses, along with the sizeable regulatory penalties it had to face (Cusumano, 2011). However, Toyota failed to recognize the precise supply chain risk posed by the ongoing sequence of events for all these years. Not only was it highly ambiguous in recognizing the risk that the situation posed, but it also failed to ascertain the impact of the disaster on the firm. The extended time Toyota took to realize the enormity of the risk involved in the ongoing sequence of events led to a more extensive and damaging impact due to the ongoing production and sale of cars with defective brake pedals.

A recent deep water oil spill disaster is another case in point, wherein tier I supplier, Transocean, and the rig owner, British Petroleum, though aware of the continuous and significant production disruptions being caused by multiple operational failures, failed to precisely and unambiguously ascertain that an ongoing sequence of critical failures were building up to a disaster of a much larger magnitude ("A BP lesson," 2010). Not only were the firms ambiguous about the imminent crisis, they were also found to be critically lacking in their ability to gauge the impact or devise an appropriate response strategy. Both firms suffered huge financial losses in addition to irrecoverable damage to their brand values. In another example, Foxmeyer, the second largest North American drug distributor in 1996, exhibited similar ambiguities when faced with repeated glitches with the newly installed ERP and automation systems at its distribution centers ("Supply chain disasters," 2009). It kept questioning whether the glitches, which were already causing operational stoppages, were 'deal-breakers'; the dithering proved extremely costly and led to losses in the millions of dollars due to shipping errors. Foxmeyer never fully recovered from the impact, leading to the once $5 Billion company being taken over by its rival for a mere $80 Million.

Similarly, Boeing, in its objective to manufacture more aircrafts and reduce its production lead time, did not fully recognize the risk associated with its strategy of outsourcing the design and manufacturing of critical components to inexperienced suppliers until the compounded and recurrent problems led to $2 Billion in additional costs and the cancellation of orders from its leading customers (Tang and Zimmerman, 2009). Likewise, Cisco's ambiguity in reading the risks associated with changing market demands and its confusion regarding the appropriate response strategy led to a failure to act quickly and adequately in response to the slowing demand for IT infrastructure equipment, which led to huge inventory build-ups at various stages of the supply chain and ultimately resulted in a $2.2 Billion inventory write-off (Lakenan et al., 2001).

An appropriate analogy to the risk recognition ambiguities exhibited in the context of supply chains can be drawn from the housing and the financial market bubble that led to the collapse of the global economy in the latter half of 2000s. Baker (2004) highlights how housing market enthusiasts exhibited ambiguity in their failure to realize that the industry was well into a crisis even though doubts and questions were raised about the continuously increasing and unsustainable property prices. In 2006, an eminent economist, Nouriel Roubini, pointed to the various signs that indicated an overinflated market; however, this observation was dismissed by the industry at large, as it failed to recognize that the industry was, in fact, already in the middle of a crisis and a housing bubble, accompanied by rapidly declining consumer confidence in the markets (Mihm, 2008).

Given the critical impact of supply chain disasters on firms on the one hand and the ambiguities demonstrated by firms in appropriately recognizing the risks arising from supply chains disruptions on the other, there is a critical need to examine the phenomenon and its drivers further. As supply chain disruptions are often characterized by sufficient information and knowledge of the disruptions, the questions I raise and address in this research are:

- *Why do firms exhibit ambiguities in recognizing and assessing the nature, scale, impact, and responses to major supply chain disruptions and the risk posed by them?*

The corollary to the question is:

- o *What are the key factors that drive the supply chain risk recognition ambiguity exhibited by firms?*

This thesis addresses the phenomenon of supply chain risk recognition ambiguity through the theoretical lens of cognitive limitation and bounded rationality (March and Shapira, 1987, Tversky and Kahneman, 1986, Simon 1976), which argues that firms, or decision makers within firms, are limited in their capabilities to objectively assess all possible situational factors and relevant information, and consequently reach a rational, objectively justified assessment of the risk inherent in a given organizational context. Bounded rationality suggests that not only might the availability of relevant information be limited, but the organizational capability to process all available information to reach the most logical conclusion can also be highly constrained. The literature on bounded rationality suggests that when faced with complex situations, firms' ability to process information and reach logical conclusion is characterized by considerable bias and sub-optimality (Tversky and Kahneman, 1986).

In supply chains, the problem of bounded rationality is further compounded by the fact that the source of information is often the environment, which lies beyond the boundaries of the firm. In the context of a supply chain, the environment external to the firm is largely the web of suppliers and customers with which the firm interacts. Specifically, the web of suppliers forms a critical conduit for materials, resources, and information relevant to supply chain decision making for the firm; hence, I focus on the characteristics of the supply networks to examine the sources of ambiguity. The quality, authenticity, and reliability of the information received and transferred in networks can have a significant impact on a firm's assessment and ability to recognize the risks and disruption potential of relevant events. The supply networks and the nature of information that emanates from them can be argued to significantly impact the firms' bounds of rational decision making, thereby affecting the ambiguity involved in risk recognition.

Supply networks can either impede or enhance risk recognition ambiguity depending on the embeddedness of the firm in the network. For example, if the firm enjoys strong relational ties with others firms in the supply network, it is highly likely that information critical to recognizing and understanding disruptions will be shared with the focal firm, which provides the firm with essential inputs that improves its ability to assess and understand the qualities and significance of the related disruptions. Additionally, owing to the high relational embeddedness shared by the focal firm with partner firms in a supply network, the focal firm can gain access to external resources and pool complementary skills to reduce ambiguity with response recognition in the event of a disruption. Conversely, at times the network dynamics might be such that they increase the risk recognition ambiguity for the focal firm, as partner firms, depending on their self-interest, might refrain from sharing critical information or provide incomplete information, thereby leading to significant ambiguity for the focal firm in interpreting and assessing the characteristics of disruptions.

Based on the above, in my research, I primarily hypothesize about and examine the role that the characteristics of supplier networks play in affecting the supply chain risk recognition ambiguity exhibited by firms. This research contributes to the literature of supply chain risk management in multiple ways. First, the study lends insights into how the attributes of events causing supply chain disruptions are fundamentally different. Through this study, I argue that not all supply chain disruptions are sudden and unpredictable. Disruptions caused by strategic and operational factors are often characterized by prior information and knowledge, to a varying extent, of the disruptions. There is a critical need to address supply chain disruptions in such a way that acknowledges the differences in the fundamental natures of natural and operational disruptions.

Second, I emphasize that despite the availability of information and knowledge on the supply chain crises, firms are highly ambiguous in their ability to recognize the potential the developing events have to disrupt the supply chain. I draw from bounded rationality to understand the ambiguity faced and operationalize the construct of risk related ambiguity by highlighting four different facets of ambiguity associated with supply chain disruption risk.

Third, I draw from the literature on inter-organizational networks to argue that network embeddedness – namely, relational, structural, and positional embeddedness – are critical to the understanding of information flow and knowledge transfer in networks. As bounded rationality is essentially an information processing problem, and thus leads to ambiguity, I propose that the focal firm's embeddedness in its supply network will impact the ambiguity it faces. I develop a causal model wherein I explore how the embeddedness of a firm in its supply chain network affects its risk recognition ambiguity. The measures of ambiguity developed here may serve as the basis for future research to examine the effect of information technology on ambiguity and the multiple mitigation strategies that can be employed to address supply chain disruptions.

The remainder of this thesis is organized as follows. In section two, I review the literature on supply chain risk that forms the basis of my key arguments. In section three, I review the conceptual underpinnings of bounded rationality and inter-organizational networks that inform the theoretical model and hypotheses. The hypotheses examine the relationships of different types of network embeddedness and their impact on the ambiguities faced by firms. In section four, I discuss the methodology, statistical analyses, and findings. In section five, I highlight the academic and managerial implications of the study. I conclude by noting the limitations of the study and offering recommendations that may guide future studies of supply disruption risk.

2. Literature Review

There has been an emerging body of literature in recent times, both conceptual and empirical, that has focused on the study of risk in supply chains. The field of supply chain management is inter-disciplinary in nature, encompassing the fields of general management (GM), operations management (OM), operations research (OR), and Management Science (MS). A list of journals based on previously published literature reviews (e.g. Tang & Musa, 2011; Petersen *et al*., 2011) and rankings published by Association of Business School (ABS), UK (Ghadge *et al.*, 2012), was selected for the review of the literature in the field of supply chain risk management. A holistic approach towards the selection of journals for the review ensures coverage of the most relevant articles given the widely dispersed nature of published articles on supply chain risk management. Table 1 below lists all the journals that I used to review the relevant literature on supply chain risk management.

I. General Management
Academy of Management Journal
British Journal of Management
California Management Review
II. Operations Management
Journal of Operations Management
Production and Operations Management
Production Planning and Control
International Journal of Production Research
International Journal of Logistics Management
International Journal of Production Economics
Manufacturing and Service Operations Management
Supply Chain Management: An International Journal
International Journal of Operations and Production Management
International Journal of Physical Distribution and Logistics Management
III. Operations Research and Management Science
Management Science
Decision Sciences
Omega: The international Journal of Management Science
Journal of the Operational Research Society

Table 1: List of Journals

2.1 Overview of the Supply Chain Risk Literature

Over the last few decades, along with the increasing focus on supply chains in general, there has been a growing interest in the issues pertaining to supply chain risk management. The largely anecdotal evidence from the industry in the late 1990s and increasing interest from academia have fueled research in this area; however, many researchers have argued that the research in the area of supply chain risk management is still in the nascent stage (Faisal et al. 2006; Khan and Burnes, 2007; Sodhi et al., 2012). Scholars have time and again drawn the attention of the research community to the need to shift attention away from anecdote-driven supply chain disruption assessment and mitigation studies to conceptual, theory driven, and empirically validated frameworks that can better identify and assess the various facets of supply chain risk and relevant mitigation practices. A short summary of the critique of the field highlighting the need for an advancement of supply chain risk management research is presented in table 2.

Study	Summary
Juttner et al. (2003)	Based on previous literature and fieldwork, the authors emphasis the need for more research to fully understand and untangle the complexity of supply chain risk management. The study points to the need for more empirically grounded research on supply chain risk management.
Juttner (2005)	An explorative study aimed at understanding practitioners’ requirements in supply chain risk management and motivating the research in SCRM beyond company specific case studies. The research develops a conceptual pyramid to address research questions in SCRM at different levels - philosophy, principles, and processes.
Khan and Burnes (2007)	This study draws the attention of scholars in the field of SCRM to the need to locate and draw from the theory of risk and risk management practices while addressing SCRM. It emphasizes the need to move from a general prescription for risk management to adapting and using the wide tools of risk management from the general risk literature.
Sodhi et al. (2012)	This study highlights the gaps in the field of supply chain risk management – a lack of consensus on the definition of SCRM, limited research on mitigation strategies, and a lack of empirical research in SCRM. The authors emphasize the need for industry case-based studies and advancement in conceptual as well as empirical work in the field.

Table 2: Key studies on research priorities and future directions for SCRM research

There is a broad consensus amongst the scholars in the field (as summarized in table 2) that research on supply chain risk management needs to evolve around three critical aspects. First, the definition and categorization of supply chain risk needs to evolve from an attribute-based conceptualization and classification to an overarching, theoretically driven study of supply chain risk. Second, there is a need to advance from loosely connected, generalized sets of tools and techniques encapsulated as a framework for supply chain risk management to empirically driven research on antecedents and drivers of, and mitigation strategies for supply chain disruptions. Third, the field may benefit immensely from attempts to draw and locate supply chain risk within broader studies of *risk* itself. An appreciation of the studies on risk in various disciplines and an understanding of supply chain risk within that context will allow researchers to appropriately adapt and advance tools and techniques from other disciplines of risk management to address supply chain risk. Informed by the above summarized assessment of the field and emphasizing the need to better understand the concept of supply chain risk (table 2), the next section focuses on the conceptualization of supply chain risk in the literature.

Supply Chain Risk & Supply Chain Risk Management

There has been an ongoing debate in the literature of risk regarding the definition and conceptualization of risk and uncertainty (Khan and Burnes, 2007). While risk has generally been associated with the negative outcomes of an event, uncertainty has been associated with both the positive and negative possibilities of an event. Researchers (e.g. Courtney et al., 1997; Hillson 2006) have made a clear distinction between risk and uncertainty but, as pointed out by Khan and Burnes (2007), scholars in the field of supply chain risk management tend not to acknowledge the debate in the general risk literature regarding the differences between risk and uncertainty, and interchangeably use the terms 'supply chain uncertainty' and 'supply chain risk' (e.g. Peck 2006; Ritchie and Brindley 2007; Tang 2006), which implies that supply chain uncertainty and supply chain risk are generally treated as the same concept in the supply chain risk management literature.

Moreover, various definitions of supply chain risk exist in the literature, which depending on the context of the study and the overall approach of the researcher, emphasize certain dimensions of the supply chain under study. A comprehensive, overarching definition of supply chain risk that takes into account all the different dimensions of supply chain risk is lacking (Manuj & Mentzer, 2008). The literature generally deals with the definition and conceptualization of supply chain risk through four different dimensions: supply risk, demand risk, operational risk, and security risk (e.g. Christopher and Peck, 2004; Manuj and Mentzer, 2008). Researchers have characterized supply risk in terms of the inability of the organization to secure the inbound resources or services, thereby, affecting the downstream supply chain in multiple ways such as delay in meeting customer demand, increasing costs, etc. (Zsidisin et al., 2004; Manuj & Mentzer, 2008). Van der Vorst and Beulens (2002) have tried to address the multi-disciplinary nature of supply chain risk and uncertainty as "decision making situations in the supply chain in which the decision maker does not know definitely what to decide as he is unclear about the objectives; lacks information about its environment or the supply chain; lacks information processing capacity; is unable to accurately predict the impact of possible control actions on supply chain behavior; or, lacks effective control actions (p.413)." This definition of supply chain risk, though more general, focusses to a great extent on the risk in supply chain due to information uncertainty, and the mismatch between information processing needs and capabilities.

In contrast, certain groups of researchers address supply chain risk through two broad categorizations: operational risk and disruption risk (Kleindorfer and Saad 2005, Tang 2006, Knemeyer et al. 2009, Wakolbinger and Cruz 2011). Operational risk is generally characterized by fluctuations in demand-supply coordination, whereas disruption risk in a supply chain refers to catastrophic events such as earthquakes, tsunami, etc. While the supply chain literature has yet to agree on an overarching definition of supply chain risk, there seems to be a better conceptualization of supply chain risk management. Tang (2006) has highlighted the 'coordination and collaboration' aspect of supply chain risk management, and Juttner et al. (2003) has emphasized the need for identification and an appropriate response strategy to reduce overall supply chain vulnerability. Based on these broad understandings of supply chain risk, I next examine how researchers have assessed the key drivers of supply chain risk.

2.2 Antecedents and Drivers of Supply Chain Risk

The complexity and increasing interdependency of the partners in a supply chain is credited with the overall reason for various types of supply chain risk that organizations have to deal with in today's uncertain environment (Barry, 2004; Trkman and McCormack, 2009). The large swings in order placement patterns as one moves up a supply chain, also known as the 'bullwhip' effect in the literature, have often been a research focus, as some of the frequently observed supply chain risks such as inventory pile-up, obsolescence risk, and chaos risk have been attributed to information gaps in the chains (Chen, Drezner, Ryan, and Simchi-Levi, 1999; Lee, Padmanabhan, and Whang, 2004; Norrman and Jansson, 2004).

Juttner et al. (2003) classified the possible sources of supply chain risk into three groups: 1) external to the supply chain, 2) internal to the supply chain, and 3) risk related to the network characteristics of the supply chain. Another attempt at a broad classification of the sources of supply chain risk was undertaken by Rao and Goldsby (2009), who identified 'framework factors' (consisting of environmental, industry, and organizational factors), problem-specific factors, and decision-maker related factors. A summary of the literature that dwells on and examines the sources and drivers of supply chain risk and disruption can be found in table 3. The coverage of the sources of supply chain risk, though extensive and detailed in the literature, is also characterized by a lack of frameworks or models with relevant and adequate theoretical underpinnings that explains the manifestation of risk in supply chain.

Through an exhaustive examination of the sources of risk, it can be noted that diverse categorization of sources of supply chain risk exist in the literature. Spekman and Davis (2004) viewed supply chain risk as arising from the flow of material, information, and money, and classified risk in terms of supply risk, information flow risk, money flow risk, internal IT risk, partner's opportunism risk, and corporate responsibility risk. At the basic level, Christopher and Peck (2004) categorize supply chain risk as 1) internal to the firm (Process & Control risk), 2) internal to supply chain (demand & supply risk), and 3) external to the supply chain (environmental risk). Another widely cited categorization is that of Kleindorfer and Saad (2005), which further sub-categorizes the widely discussed and exemplified kind of supply chain risk, namely disruption risk, into operational contingencies; natural hazard such as earthquake, tsunamis, etc.; and terrorism and political uncertainty.

While these researchers hold widely different perspectives and approaches to the classification of supply chain risk, many researchers seem to agree to some extent that supply chain risk can be broadly grouped into 1) supply risk, 2) demand risk, 3) process risk, and 4) environmental risk (Christopher and Peck, 2004; Bogataj and Bogataj, 2007; Sodhi and Lee, 2007; Tang and Tomlin, 2008; Manuj and Mentzer, 2008). Given the lack of overall agreement regarding a comprehensive typology of supply chain risk and the differences between similar categorizations of the definition and boundaries of risk types, this literature review will broadly summarize different types of supply chain risk with the intention of providing an understanding of the different possibilities of risk in supply chain.

Supply risk

Supply risk is the risk associated with the negative consequences of the supply (raw material/semi-finished goods or final product) being delayed, of inferior quality, and/or of inadequate quantity from the upstream supply chain to the downstream partners (Bogataj and Bogataj, 2007). Supply risk generally deals with the operational characteristics of the supply chain and tends to be conceptualized in the literature as accounting for process variations in the supply chain. Dependency on a single source and the shift towards lean supply chains with the

Study	Methodology	Summary
Braunscheidel and Suresh (2009)	Survey	Investigates the impact of two cultural antecedents, market orientation and learning orientation, and three organizational practices, all aimed at augmenting the supply chain agility of a firm.
Choi et al. (2006)	Conceptual Development	Proposes supply base complexity and level of differentiation among suppliers as antecedents to supply risk.
Ellis et al. (2010)	Survey	Explores the relationship between the antecedents of supply disruption risk (supply market characteristics – market thinness & technological uncertainty – and product characteristics – item customization and importance) and buyer's perception of supply chain disruption risk.
Jiang et al. (2009)	Survey	Untangles the antecedents of labor turnover problem in China's manufacturing industry. The study argues that high labor turnover leads to serious production and quality issues which increase the risk of supply chain disruptions. The study highlights meager HRM practices and unfair buyer behaviors as the root causes of labor dissatisfaction.
Kull and Closs (2008)	Simulation	Examines the supply risk issue within the context of a second-tier supply failure and is grounded in inventory and resource dependency theories.
Rao and Goldsby (2009)	Conceptual Development	Reviews the literature on sources of supply chain risk. The authors develop a typology of risk sources - framework factors, problem specific factors, and decision maker factors - in order to advance risk source and vulnerabilities identification within supply chains.
Ritchie and Brindley (2007)	Case study	Examines case studies to understand the relationship between dimensions of risk and performance in supply chains. Identifies and presents the framework with a multitude of risk sources.
Speckman and Davis (2004)	Conceptual Development	Presents different types of risk associated with a supply chain ranging from the most obvious, visible and easy to discern the risks inherent in managing highly collaborative supply chains.
Thun and Hoeing (2011)	Survey	Finds that supply chain complexity such as globalization, product variety, and efficiency improvement measures such as outsourcing and supply base reduction are the key drivers of supply chain risks. The results reveal that internal supply chain risks are regarded as more likely to occur and that they also have a greater impact on the supply chain.
Trkman and McCormack (2009)	Conceptual Development	Presents a method for the assessment and classification of supplier risk based on the characteristics, performance, and environment of the industry.
Vorst and Beulens (2002)	Case study	Shows that in order to have effective SCRM strategies, it is essential to identify and manage the sources of uncertainty in supply chains. In the three case studies discussed, identification of the nature of the uncertainties led to the effective implementation of mitigation strategies.
Wagner and Bode (2008)	Survey	Finds that supply chain characteristics (a firm's dependence on certain customers and suppliers, the degree of single sourcing, reliance on global supply sources) are relevant for a firm's exposure to supply chain risk.
Zsidisin (2003)	Case study	Describes the characteristics of inbound supply that affect managerial perceptions of supply risk and provides a classification of supply risk sources. The authors use case studies to focus on supplier quality issues and performance, and help firms assess the likelihood and impact of supply side disruptions.

Table 3: Representative list of studies on antecedents and drivers of supply chain disruption

objective of minimizing costs has over the period of time increased the severity and consequences of supply chain risk (Tang and Tomlin, 2008). Supply risk can be further sub-categorized into multiple components depending in the context of study such as business risk, supplier capacity constraints, quality, technological challenges, and product design challenges (Zsidisin et al., 2000).

Demand Risk

Variation in the demand quantity and demand mix of different products in the market (Tang and Tomlin, 2008) can have a catastrophic effect on the supply chain if not managed properly. Often unpredictability in demand can lead to a situation of stock-out or excess inventory (Sodhi, 2005) and this can be more significant in the case of seasonal products or products in the technological domain where the product life cycle is very short (Christopher and Lee, 2004). The frequency and impact of demand risk is dependent on various factors such as the economy, market response, competition, and seasonality.

Process Risk

Processes are series of value-adding actions and managerial decisions and activities taken with an objective to obtain certain results (Christopher and Peck, 2004). In supply chains, processes are generally internal to the firm, and the implementation and normal functioning of these processes are the responsibility of the firm. The risk posed to the supply chain due to variation, breakdown, or disruption in these processes at firms constituting a value chain is classified as a process risk (Bogataj and Bogataj, 2007; Cavinato, 2004; Kleindorfer and Saad, 2005). For example, a critical machine breakdown is a process risk as it can potentially disrupt the flow and availability of products for firms upstream in the supply chain. In a manufacturing supply chain, process risk can also occur when a particular product in the chain is not produced in time, in the required quantity, and/or at the desired quality.

Environmental Risk

The environment is external to the supply chain and the individual organization. It includes factors apart from the operational characteristics of the supply chain such as political factors, earthquakes, tsunamis, factory fires, terrorism, geographical factors such as proximity, and geographical concentrations of suppliers or consumer markets, among others (Bogataj and Bogataj, 2007; Jüttner, Peck, and Christopher, 2003). The risk posed to a supply chain because of environmental uncertainty in the supply chain is defined as environmental risk. The large number of natural disasters in the last decade has brought significant attention on the study of the causes and consequences of environmental risk to supply chain profitability and performance (Hendricks and Singhal, 2005; Wilson, 2007; Wagner, and Bode, 2008).

2.3 Impact of Supply Chain Disruptions

Research in supply chain risk management is predominately motivated by the disastrous consequences of disruptions faced by firms. There is no dearth of anecdotal practitioner articles highlighting and discussing at length the devastating impacts of supply chain disruptions. For example, the March 17, 2000, fire at the Philips factory and its effect on Ericsson, the leading mobile phone manufacturer of the time, is often discussed in supply chain disruption literature (Sheffi and Rice Jr, 2005). The reported loss of $ 2 Billion by Ericsson for that year and the announcement in the following year of a mobile phone division merger with Sony is attributed to Ericsson's inability to fully recover from the specific supply chain disruption.

However, the direct cause-effect relationship between supply chain disruptions and the firm performance, specifically the financial parameters, remained mostly elusive until Hendricks and Singhal (2003) studied the direct relationship between disruption and stock performance. A summary of this research is presented in table 4. These studies provide more structured and rigorous accounts of what was previously largely reported through anecdotal stories of supply chain disruptions.

Study	Methodology	Summary
Hendricks and Singhal (2003)	Secondary data	Investigates the association between supply chain glitches and financial performance based on event studies. Supply chain disruptions erode the shareholders' value by 10.28%. Larger firms and firms with higher growth prospects pay more dearly in terms of stock returns in the event of a disruption.
Hendricks and Singhal (2005)	Secondary data	Examines the impact of supply chain disruption on the stock price of the firm. The research highlights the significant negative economic consequences (40% below normal stock return) and the extended recovery period as pointing to the need to pay attention to risk of disruption.
Hendricks et al. (2009)	Secondary data	Provides empirical support for the impact of supply chain disruption management strategies on firm's stock returns. It demonstrates that firms with more slack in their supply chain and a high degree of vertical relatedness experience less negative stock market reaction, whereas firms that are more geographically diversified experience a more negative stock market reaction in the event of disruption.
Wieland and Wallenburg (2012)	Survey	Demonstrates that SCRM, which encompasses identification, assessment, and mitigation of risk, increases business performance and supply chain's customer value through the mediating role of agility and robustness.
Wu et al. (2007)	Modeling	Determines through a modeling-based study the system-wide effects of disruptions in supply chains. The study provides a better understanding of disruption propagation through supply chains and its impact on performance.

Table 4: Representative list of studies on impact of supply chain disruptions

2.4 Supply Chain Risk Mitigation and Response

The risk mitigation strategies discussed in the extant literature can be broadly grouped into generic risk mitigation strategies, which primarily involve general frameworks or guidelines to manage or respond to different kinds of supply chain risk; and specific response strategies and typical risk management strategies pertaining to particular aspects of supply chains. Blackhurst et al. (2005) provide a general framework for addressing disruption risk in supply chains through disruption discovery, disruption recovery, and supply chain redesign. Similarly, Zsidisin et al. (2005) discussed four stages: awareness, prevention, remediation, and knowledge management for effective supply chain risk management. While the general frameworks discussed above do provide an overall guiding path, they fail to provide the detailed model required to handle context-specific supply chain disruption risks as the responses required will vary depending on the source, magnitude, and impact of the supply chain disruption. Hence, a few researchers have argued that an overall and generalized risk assessment and management approach will not be very effective in dealing with the diverse nature of supply chain risk.

Researchers exploring more context specific risk mitigations strategies have highlighted the salience of various contingencies and how risks can be dealt with under specific circumstances. While some researchers focused on context-specific mitigation and response strategies have highlighted issues such as supplier risk and risks arising from supplier selection, monitoring, and assessment (Matook et al 2009; Blackhurst et al 2008; Deane et al 2009; Sawik 2011), and contingency planning and flexibility (Skipper and Hanna 2009; Tomlin 2006; Wang et al 2010; Yang et al 2012; Kleindorfer and Saad 2005), others have focused on the supply chain's ability to deal with such risks as supply chain adaptability, flexibility, and agility (Merschmann & Thonemann 2011; Tang & Tomlin 2008; Makris et al. 2011; Braunscheidel & Suresh 2009; Prater et al. 2001), and supply chain visibility and information accuracy (Christopher & Lee 2004; Blackhurst et al. 2005). A summary of the literature examining supply chain risk mitigation strategies is presented in table 5.

Study	Methodology	Summary
Babich et al. (2007)	Modeling	Focuses on disruption risks in supply chains with one retailer and competing risky suppliers, considers the effect of supply risks, and suggests diversification as a risk mitigation strategy.
Bode et al. (2011)	Survey	Relates the application of mitigation strategies - buffering and bridging - as the response mechanism invoked by a firm in response to supply chain disruptions. The study also lends insights into the factors that motivate firms to activate these specific response mechanisms.
Boone et al. (2007)	Conceptual Development	Highlights postponement as a supply chain uncertainty mitigation strategy as it delays supply chain activities until the latest possible moment.
Chen et al. (2013)	Survey	Investigates elements of SC collaboration – supplier, internal, and customer collaboration as mitigation strategies to handle supply, demand, and process risk.
Christopher & Lee (2004)	Conceptual Development	Presents supply chain end-to-end visibility and improved confidence due to increased information as drivers of a supply chain risk mitigation strategy.
Craighead et al. (2007)	Case study	Derives through conceptual work six propositions relating the severity of supply chain disruptions to the supply chain design characteristics of density, complexity, and node criticality, and to the supply chain mitigation capabilities of recovery and warning.
Deane et al. (2009)	Modeling	Develops a decision support tool that offers supply risk mitigation when sourcing globally. Specifically, the tool allows for the analysis and mitigation of two key global risk measures, environmental risk and density risk, when selecting suppliers for mission-critical parts.
Dowty and Wallace (2010)	Case study	Demonstrates through case studies how an organization's cultural bias shapes the way the organization uses internal rules and external standards when coordinating with other supply chain partners. The study highlights poor cultural understanding as a hindrance to effective supply chain disruption management.
Ellegaard (2008)	Case study	Determines how owners of small manufacturing companies manage supply risk and identifies the practices constituting their approach.
Ellis et al. (2010)	Survey	Explores the role of supply chain risk perception in the risk mitigation decision-making process. Buyers' decisions to search for alternate suppliers are motivated by their perception of overall supply chain risk, which is further guided by the probability and magnitude of the event.
Faisal et al. (2006)	Modeling	Develops and classifies the variables that would help to mitigate supply chain risks as independent variables such as trust, collaborative relationships, and information sharing, and linkage variables such as strategic risk planning and revenue sharing policies.
Giunipero and Eltantawy (2004)	Conceptual Development	Argues that SCRM are successful and effective when factors relevant to the firm are taken into consideration in formulating mitigation strategies. It states that situational factors – the degree of product technology, security needs, the relative importance of suppliers, and prior experience – are critical to the process of effective and efficient risk management.

Hallikas et al. (2004)	Case study	Provides support for a network approach to risk mitigation strategy. The presented processes facilitate understanding and managing uncertainties and risks in supplier networks.
Hult et al. (2010)	Survey	Operationalizes supply chain uncertainty and different supply chain options (unlocking, stage, deferral, scale, and switch) and explores how firm-level decision makers' use of the options will be related to perceived value under conditions of high supply chain risk uncertainty.
Jia and Rutherford (2010)	Conceptual Development	Proposes cultural adaptation as a mitigating strategy against supply chain relational risk caused by cultural differences.
Khan et al. (2008)	Case study	Suggests that product design and the sourcing decisions related to it - sourcing, choice of materials, physical characteristics - can play a significant and successful role in SCRM. Through a case study, it demonstrates the effectiveness of design-led risk management strategies.
Kleindorfer and Saad (2005)	Case Study	Advocates for strategies and actions aiming at reducing the frequency and severity of risks faced and increasing the capacity of supply chain participants to sustain/absorb more risk without serious negative impacts or major operational disruptions.
Knemeyer et al. (2009)	Conceptual Development	Presents a holistic approach to identify key locations susceptible to catastrophic disruption, assess the probability and magnitude of the event, and plan appropriate countermeasures to mitigate the potential effect of the event on the supply chain. It draws from several diverse literatures to propose a process that allows managers to gather information that would assist in the identification and mitigation of supply chain disruptions.
Manuj and Mentzer (2009)	Conceptual Development	Proposes a conceptual model stating that temporal focus, supply chain flexibility, and supply chain environment act as antecedents to SCRM strategy selection and that the complexity of the supply chain and extent of inter-organizational learning moderates the link between strategy selection and outcome. The paper addresses the gap regarding the need to link antecedents to appropriate SCRM strategies.
Merschmann and Thonemann (2011)	Survey	Operationalizes and explores the relationship between supply chain uncertainty and flexibility, and proposes that a fit between the two leads to higher performance for the company.
Norrman and Jansson (2004)	Case study	Presents a framework to analyze, assess, and manage risk sources along the supply chain including the firm, its suppliers, and its sub-suppliers.
Oke and Gopalakrishnan (2009)	Case study	Argues through a case study that classifying supply chain risks as high-likelihood, low-impact, and low-likelihood high-impact is highly relevant and identifies the appropiate generic and specific mitigation strategies for each category.
Peck (2006)	Case study	Argues through conceptual work that supply chain vulnerability and supply chain risk management require distinct treatment at the operational and strategic level to manage disruptions in supply chains.
Prater et al. (2001)	Case study	Presents speed and flexibility as two important attributes of supply chain agility necessary to manage uncertainty in an increasingly complex supply chain.
Schmitt and Singh (2012)	Modeling	Assesses the relevance of specific strategies for mitigating disruption risk. The study evaluates the impact of inventory placement and buffer management in the supply chain network to manage supply disruption and demand uncertainty.

Skipper and Hanna (2009)	Survey	Demonstrates that primary planning attributes such as top management support, resource alignment, information technology usage, and external collaboration increase supply chain flexibility and enhance contingency planning processes. Researchers suggest that the identification of key variables in contingency planning increases the likelihood of successful implementation in the event of supply chain disruptions.
Sinha et al. (2004)	Conceptual Development	Proposes a methodology for mitigating risks in the aerospace supply chain.
Tang (2006)	Conceptual Development	Provides risk mitigation strategies to enable the supply chain to absorb inherent variations and improve the resiliency of the supply chain in the event of disruptions. The author suggests that – supply alliance network, lead time reduction, and recovery planning systems will minimize the effect of supply chain disruptions.
Tomlin (2006)	Modeling	Advocates for an active disruption management strategy based on mitigation and/or contingency actions. The author states that the optimal supply-side disruption mitigation strategies - sourcing mitigation, inventory mitigation, and contingency rerouting - will be determined by cost, supplier characteristics, firm characteristics, and disruption length.
Wakolbingera and Cruzb (2011)	Modeling	Investigates an information sharing mechanism and risk sharing contract as mitigation strategies in the event of disruptions to a supply chain. Researchers suggest that information sharing directly benefits the supply chain and also moderates the positive relationship between risk sharing contract and performance in the event of disruptions.

Table 5: Representative list of studies on supply chain risk mitigation and response strategies

In summary, a rich and significant body of literature has examined, addressed, and researched the antecedents, causes, and drivers of supply chain risk and disruption. Scholars have also suggested frameworks and specific disruption mitigation strategies that can be implemented or activated in response to disruptions. However, as pointed out by a few scholars, the literature on supply chain risk still lacks a proper definition and conceptualization of risk and risk management in supply chains, which has led to confusion in terms such as supply chain risk, vulnerability, uncertainty, and sources of risk (Manuj and Mentzer, 2008). Moreover, the overall research also suffers from a lack of theoretical approaches and explanations that describe the nature of risk faced by supply chains, their antecedents, and their consequences. Except for few studies (Bode et al., 2011; Choi and Krause, 2006; and Hult et al., 2010), there is a significant gap in the literature regarding the response and the need for strategies for supply chain risk from a theoretical perspective.

More important, however, especially from the point of view of the present study, in most studies, there appears to be an implied fundamental assumption that supply chain managers have a complete and accurate understanding of supply chain disruptions and that the decision-making process in response to these disruptions is characterized by absolute knowledge and an unlimited information processing capability. The implications of this fundamental assumption are visible in various studies that cite and examine the varying degrees of success achieved by firms in anticipating, accessing, and mitigating supply chain disruptions with similar disruption management mechanisms. As exemplified and discussed in previous section, there is significant ambiguity in anticipating, assessing, and responding to disruptions. Firms are largely ambiguous in their ability to recognize disruptions and frame optimal response strategies due to cognitive limitations and a limited information processing capability. Therefore, there is a need to study the mechanism of ambiguity faced by a firm in a supply chain to better capture its ability to assess and respond adequately and successfully to supply chain disruptions. I extend the line of research in this discipline that has examined managerial assessment and decision making in supply chain when faced with high uncertainty (Boone, Craighead, and Hanna, 2007; Hult, Craighead, and Ketchen Jr, 2010; Yang, Burns, and Backhouse, 2004).

3. Theory and Hypotheses

In this section, the first sub-section discusses the theoretical reasoning of organizational ambiguity in supply chains. I examine organizational ambiguity through the theoretical bases of bounded rationality and cognitive limitation. In addition, this sub-section introduces the four types of ambiguity relevant in supply chains – risk recognition, impact recognition, response recognition, and partner response ambiguity. The second sub-section details the embeddedness of relationships in supply chain networks. This sub-section highlights that the embeddedness of a firm in its network can be described in three forms – relational, structural, and positional. The intrinsic characteristics of each type of embeddedness are further discussed in this section. The third and the final sub-section provides arguments for the hypothesized relationships between various types of embeddedness and categories of organizational ambiguities in supply chains.

3.1 Ambiguity and Bounded Rationality

In this sub-section, I draw from the theoretical bases of bounded rationality and cognitive limitation to argue that the organizational ambiguities associated with recognizing and responding to supply chain risk are primarily an information processing problem. Following Simon (1976) and Tversky and Kahneman (1986), I understand bounded rationality as a phenomenon that limits the rationality of the actions organizations resort to when faced with complex situations. Bounded rationality sheds light on organizational sub-optimal decision making as organization, in general, has to deal with three important constraints in the process of decision making: 1) the limited availability and reliability of the information regarding the available options and their consequences; 2) limited information processing capacity, i.e., cognitive limitations to the amount of information that can be analyzed and processed given the complexity of the environment; and 3) the ever-present time constraints within which organizations need to make decisions. Proponents of bounded rationality advocate that as firms are subjected to the constraints and costs associated with information gathering and information processing, the possibilities of rational decision making that firms seek to achieve are, in fact, limited. The limits on rational analysis imply that organizations cannot anticipate and analyze each and every possible scenario that can play out in a complex environment due to the limited information as well as the limited information processing capability they have. This lack of a clear understanding, due to bounded rationality and cognitive limitation, of the environment and how various elements in the complex environment will interact to determine the future state, generates organizational ambiguity.

Studies have indicated that bounded rationality and cognitive limitation manifest themselves in multiple forms. For example, the cost of a transaction in Williamson's (1985) transaction cost perspective is built on bounded rationality arguments that limit the capability of both managers and contracts to control incentives and opportunism. Williamson's seminal work further highlights that while organizations that are part of a contractual agreement will not always act opportunistically, the ability of management to distinguish parties that can act opportunistically from those with co-operative intentions is impended by an inadequate availability of information and constrained by a limited information processing capability. Scholars in the field of organizational strategic decision making have acknowledged that sub-optimal strategy making in organizations, given the complexity of the environment, is a manifestation of bounded rationality and cognitive limitations (Fredrickson and Mitchell, 1984; Miller, 1987; Eisenhardt and Zbaracki, 1992; Schuler, 1996; Delios and Henisz, 2000). Bounded rationality and cognitive limitation also manifest primarily as information gathering, and processing problems across multiple studies spanning various research areas. Many of these works have incorporated bounded rationality as an underlying phenomenon that moderates and/or mediates relationships between variables, for example, the relationships between collaboration and performance (Shrader, 2001); explorative innovation and performance (Siggelkow and Rivkin, 2006); strategy standardization and export performance (Shoham, 1999); and pricing strategy and demand (Che, Sudhir, and Seetharaman, 2007).

The concepts of bounded rationality and cognitive limitation have been explained and extensively discussed by researchers; however, few researchers have attempted to operationalize and provide a practitioner-centric idea of bounded rationality, particularly in the form of ambiguity. Ellsberg (1961) defines ambiguity as a “quality depending on the amount, type, reliability, and 'unanimity' of information” (p. 657). Frisch and Baron (1988) provide a more general definition of ambiguity as the “uncertainty created by missing information that is relevant and could be known” (p. 152). While there are many types of ambiguity that have been researched and studied, such as ambiguity about probability, casual ambiguity, outcome ambiguity, and contextual ambiguity, among others, its essence as an inability to be clear and unequivocal is explicitly or implicitly demonstrated. Ambiguity in a broad sense generally implies a lack of clarity due to a lack of information and information processing capability, however, the literature suggests that different scenarios or situations will be characterized by specific traits that can be better understood as different types of ambiguities. For example, casual ambiguity is defined as a "basic ambiguity concerning the nature of the causal connections between actions and results" (Lippman and Rumelt, 1982, p. 418). Outcome ambiguity, defined as the uncertainty in assigning probabilistic estimates to the possible outcome, has been examined as influential factor in managerial decision making (Ho, Keller and Keltyka, 2001).

I build on the notion of bounded rationality and cognitive limitation to further the argument that ambiguity can exist in multiple forms and that it is necessary and essential to distinguish between these forms to capture the essence of overall organizational ambiguity. Due to the cognitive limitations of the decision makers as compared to the complexity of the environment, ambiguity already exists in terms of understanding the event or the state of the environment (Downey et al., 1975; Duncan, 1972; Milliken, 1987). The limits to rationality and a limited information processing capability will prevent the decision maker from considering all the information to arrive at a perfectly rational understanding of the environment. In the context of supply chain disruptions, I conceptualize this form of ambiguity as *risk recognition ambiguity*, which is essentially the inability to assimilate and process all information to approach an unambiguous understanding of the environmental event that poses a potential threat or hazard for the firm. These limits also exist when firms assess the consequences of the potential threat or risk, which are conceptualized as *impact recognition ambiguity* (Milliken, 1987). The ambiguity in assessing the effect may prompt the decision maker to employ sub-optimal procedures in deciding on a response strategy, thus preventing the decision maker from making an informed choice and leading to further ambiguity. I refer to this type of ambiguity as *response recognition ambiguity*. In a supply chain, it is also essential to understand the ambiguity faced by the focal firm due to equivocality in the behavior of other firms that are part of the same network, which I refer to as *partner response ambiguity*. The proposed typology of ambiguity is further elaborated below.

Risk Recognition Ambiguity

A firm faces risk recognition ambiguity owing to its inability to assimilate and process all required information in a timely manner in order to understand the potential risk that the developing events in its supply chain will cause a supply chain disruption (Ashill and Jobber, 2010; Milliken, 1987; Van der Vorst & Beulens, 2002). Thus risk recognition ambiguity is the inability to ascertain the threats posed by the constantly changing dynamics of supply chain. More specifically, I define risk recognition ambiguity as *the extent to which decision makers have an ambiguous and incomplete understanding of the impending hazards, threats, or disruptions in the supply chain.* The focus is not on the firm's ability to predict a specific future state of the supply chain. Even if the firm has all the required information, it is not possible to be absolutely certain about the degree of risk the developing scenario poses to the supply chain. The firm's ability to recognize and make a perfectly rational assessment of the situation is in fact limited.

Impact Recognition Ambiguity

Impact recognition ambiguity refers to the inability to be clear and certain about the impact of the disruptive supply chain events and is defined as *the extent to which decision makers are ambiguous about the exact nature, significance, and magnitude of the impact that a major supply chain disruption can have on their firms.* Given the uncertainty involved in gauging the impact of a disruptive event, studies in the supply chain literature have considered the consequences of uncertainty and risk as an important factor (Berger, Gerstenfeld, and Zeng, 2004; Ruiz-Torres and Mahmoodi, 2007; Shin, Collier, and Wilson, 2000). The uncertainty associated with the impact of an event was amply demonstrated when a fire incident at a sub-supplier for Ericsson was the major reason that led to ultimate withdraw from the mobile terminal business (Norrman, and Jansson, 2004). Impact recognition ambiguity refers to ambiguity in understanding the cause-effect relationship in supply chains. For example, in case of an earthquake in Japan or flooding in Thailand, the automobile OEMs in North America with a large number of suppliers in Japan will be no longer be ambiguous about impending disruptions to their supply chains. However, the degree of impact of the event on the OEM will be dependent on multiple factors such as the suppliers' capability to withstand disruptions, the degree of damage caused to the suppliers, and also the focal firm's ability to quickly activate contingency plans. Given the multitude of factors that could play a role in deciding the actual impact on the focal firm, the firm will be ambiguous in ascertaining the impact of supply chain disruptions. Impact ambiguity arises from the fact that it is almost impossible to ascertain all the combinations of factors or specify the contributing role of each factor that would contribute to the actual impact on the firm.

Response Recognition Ambiguity

Response recognition ambiguity is characterized by the inability to list all possible response options, weigh perfectly the pros and cons of each option to decide on the best response strategy, and be completely certain that the consequences will be as expected (Pagh, and Cooper, 1998; Tarnef, 2011; Yang and Yang, 2010). It is defined as *the extent to which decision makers are ambiguous about response options, or the effectiveness or relative importance of response options in addressing the effects of a major supply chain disruption.* In the event of supply chain disruptions, a firm is most likely to respond rather than be a passive spectator and suffer the consequences. Response recognition ambiguity arises as and when a firm has to respond with limited information about an event and potential response strategies within a stipulated time frame. The demands and time constraints of the situation put pressure on the firm to be perfectly rational in its choice of response mechanism in the face of a limited information processing capability. A firm faces ambiguity not only in its choice and deployment of a response mechanism, it is also ambiguous about the effectiveness of its response. The effectiveness of the response strategy is highly dependent on the characteristics of the environment under consideration.

Partner Response Ambiguity

In supply chains, significant ambiguity resides in the response mechanism of partner firms in the supply network (Artz, and Brush, 2000; Hawkins, Wittmann, and Beyerlein, 2008;

Leuthesser, 1997). As a supply chain is only as strong as its weakest link, the partner firm's response aptitude and attitude towards disruptions will have a significant impact on the focal firm's ability to deal successfully with supply chain risks. I define partner response ambiguity as *the extent to which decision makers are ambiguous about supplier firms' actions, moves, or signals in the event of a major supply chain disruption.* For example, a partner firm can prioritize its customers' orders depending on its interest and its objectives when faced with constraints due to disruptions. When the Philips chip manufacturing plant was hit by lighting causing a fire that severely affected its production capacity, Philips decided to prioritize the order requirements of Nokia over Ericsson (Sheffi and Rice Jr, 2005). This highlights the significant ambiguity a focal firm faces regarding the response mechanisms of partner firms in the event of a supply chain disruption. It would have been extremely difficult for Ericsson to predict Philips' response prior to the disruption. Even with many mitigation strategies in place, Ericsson would not have had sufficient knowledge to be unambiguous about Philips' response.

Opportunism is another factor that can lead to partner firm response ambiguity. Opportunistic or co-operative behavior will vary from firm to firm. In a supply chain, it is often the case that a focal firm will invest significantly in its supply base to attain superior supply chain performance. These investments are often characterized by high asset specificity and dedicated resources that cannot be easily applied to another relationship. Depending on the degree of specificity, the partner firm may opt for opportunistic behavior instead of co-operation and co-ordination, thereby holding the focal firm hostage to its objectives in the event of a disruption.

3.2 Supply Chain Relationships: Dyads and Networks

In supply chains, a major contributor to organizational ambiguity is often the environment, specifically the web of suppliers that forms a critical conduit for materials, resources, and information; hence, I focus on the characteristics of these supplier networks to examine the sources of ambiguity. As such, this sub-section discusses in detail the relational, structural, and positional characteristics of supply chain relationships in addition to briefly discussing the relational aspect of supply chains previously examined in the literature.

The buyer-supplier relationship, defined as an "ongoing recurrent supply partnership" (Mesquita and Brush, 2008, p.785), was traditionally viewed as an adversarial competitive relationship in the industry. Over the past decade, this relationship has gradually shifted from that of competition to co-operation, co-ordination, and collaboration in order to gain competitive advantage over other firms in the industry (Emshwiller, 1991), reduce the effect of an uncertain business environment (Lee, Yeung and Edwin Cheng, 2009), act as a buffer against exogenous shocks (Miner, Amburgey, and Stearns, 1990), and improve performance outcome (Hagedoorn, and Schakenraad, 1994). This tectonic shift in the approach to the buyer-supplier relationship from resource appropriation to a knowledge-based, shared relationship, however, is still largely analyzed at the dyadic level. The dyadic level of analysis does not account for the fact that buyer-supplier interactions are embedded in the larger context of social structure, and economic actions are bound to be influenced by the embeddedness of the dyads in the broader environment (Granovetter, 1985).

For example, Toyota has strong relationships with its suppliers as compared to U.S. automakers, which helped reduce its overall operating costs by \$300-\$500 per car for Toyota in the North American market (Dyer and Hatch, 2006). Toyota's strong buyer-supplier relationships, characterized by high asset specificity such as site specificity, physical asset specificity, and human asset specificity, led to high performance in terms of product quality, new product cycle time, inventory cost, and profitability (Dyer, 1996). However, Williamson's (1981) transaction cost economics states that high asset specificity can lead to opportunism by suppliers, which has the potential to jeopardize the benefits of the relationship. Also, increased asset specificity increases the co-ordination costs, which outweighs the benefits of the relationship. Williamson (1981, 1991) postulates that increased co-ordination costs and opportunism risks will propel the buyer-supplier relationship towards vertical integration. Yet, Toyota enjoys low co-ordination cost and opportunism risk from its supplier leading to above-the-normal performance and is far from being vertically integrated with its supplier.

A broader perspective of buyer-supplier relationships in the context of a network can potentially explain the apparently conflicting differences in the literature as exemplified above. Due to Toyota's policy of encouragement for resource and knowledge collaboration and sharing among its suppliers in the closely-knit supplier base, any act of opportunism by the supplier would be known to other suppliers in the network, and hence the possibility of the act being hidden from the buyer firm is slim (Dyer and Hatch, 2006). Opportunism could lead to fall out of the supplier from the network and potential business loss. Also, being a part of a network provides the supplier with an understanding that an act of opportunism would affect the focal automotive firm negatively, for example, through quality issues and reduced sales which would ultimately impact the business volume the supplier receives from the buyer firm, thereby reducing its own performance. This is how the study of buyer-supplier relationships from a network perspective explains outcomes that remained unanswered or contradictory at the dyadic level.

In a dyadic framework, the exchange relationship specific to the two firms is the focus, not accounting for the fact that the context of the relationship is influenced by the social, political, and economic considerations of the environment. While a dyadic focus helps us study in detail the operational interactions between two firms, a broader network perspective is more useful in explaining the supplier-buyer relationship.

Drawing upon the existing network research in the field of strategy (e.g. Madhavan et al., 1998) and the extension of network theory in the field of supply chain management to study supplier-buyer relationships (e.g. Choi and Kim, 2008), we define a firm's supply network as *a web of direct and/or indirect relationships that a focal firm has with other firms in its supply chain to engage in the assembly and manufacture of products and services, and to transact, exchange, and share resources, information, and capabilities.* A supply network, by definition, can extend endlessly through multiple chains of connected relationships, thereby creating a potentially boundless network. However, a firm can draw rents, both economic and social, and leverage its network connectedness only to the extent that it is knowledgeable of its network outreach. I draw from the work of Anderson, Håkansson and Johanson (1994) to posit that the transactionally relevant part of a focal firm's network is essentially the part of the network that is considered relevant and that forms, shapes, and determines the focal firm's perception of social embeddedness within the network. In other words, the group of suppliers with which a firm transacts most frequently for high value products and with which it routinely manages, plans, monitors, coordinates, and communicates, hereby referred to as the *core supplier base*, will set the boundaries of the supply network from the focal firm's perspective.

Researchers in inter-organizational networks have argued that a firm's embeddedness in its network influences its behavior. The embeddedness of a firm in a supply network is a multidimensional concept that can be further categorized into relational, structural, and positional embeddedness (Gulati, 1999). Each of these embeddednesses are independent in the sense that they are sufficient to explain certain aspects of inter-organizational ties, but at the same time, they are complementary in terms of understanding the overall macro behavior of the firm based on its network.

Relational embeddedness is the cohesiveness of ties the focal firm has with firms in its supplier network, which is built on cumulative past experiences involving non-transactional interactions, inter-personnel acquaintances, mutual assistances, and joint operational and strategic commitments. The concept captures the focal firm's willingness and promptness to undertake current exchanges and subsequent cooperation with other firms based on cumulative past interactions and exchanges with all other firms in the network (Gulati 1995; Gulati and Gargiulo, 1999; Shan, Walker and Kogut, 1994). It highlights the characteristics of relationships in the supply network, specifically the cohesiveness and strength of the ties. Relational embeddedness refers to the extent to which the focal firm in the network is confident and acknowledges the other firms' competencies and reliability.

Structural embeddedness is the degree to which the firms in a focal firm's supplier network are connected among themselves, share common practices, and encourage information and knowledge sharing among each other. A supplier's potential for gaining trust and more business share from the buyer firm is amplified if the supplier has a good relationship and reputation with other suppliers in the buyer firm's network (Choi and Krause, 2006). Also, suppliers in the network will be more comfortable conducting business and coordinating with each other if they share common ties with a focal firm that they regard as trustworthy (Ahuja, 2000; Shan, Walker, and Kogut, 1994; Powell, Koput, and Smith-Doerr, 1996).

Positional embeddedness refers to the extent of the prominence and centrality enjoyed by the focal firm within its supply network on account of its purchasing practices, ability to connect and mediate between other firms, and ability to lead key industry-wide initiatives. The position of the firm determines the role it plays in the overall supply network. Positional embeddedness refers to the significance a firm brings to a network, independent of the ties it has with specific partner firms (Anderson, Hakansson and Johanson, 1994; Choi and Hong, 2002; Choi and Krause, 2006). It goes beyond the immediate direct and indirect ties the firm has in the network and relates to the informational benefit derived from the network or the firm's position within the network to act as an indispensable conduit for knowledge and information. The position a supplier occupies in the network can increase its attractiveness to potential buyers and its ability to harness fine-grained information about buyers and suppliers alike.

3.3 Proposed Theoretical Model

Drawing on the key ideas of bounded rationality and network embeddedness, Figure 1 illustrates my proposed theoretical model which suggests the impact of the three network embeddedness dimensions on the four categories of supply chain ambiguity. The model is rooted in the notion that the supply chain environment for a firm is characterized by rapidly changing and often complex information (Choi, Dooley, and Rungtusanatham, 2001; Zhou, and Benton Jr, 2007). As previously discussed, a firm's ability to disentangle this complex information to obtain useful and relevant information is critical to its capability to address and reduce supply chain ambiguity. Firms constantly seek to minimize irrelevant and trivial information, also referred as information noise, in their drive to make informed decisions (Echols and Tsai, 2005; Rowley, Behrens and Krackhardt, 2000) and reduce ambiguities.

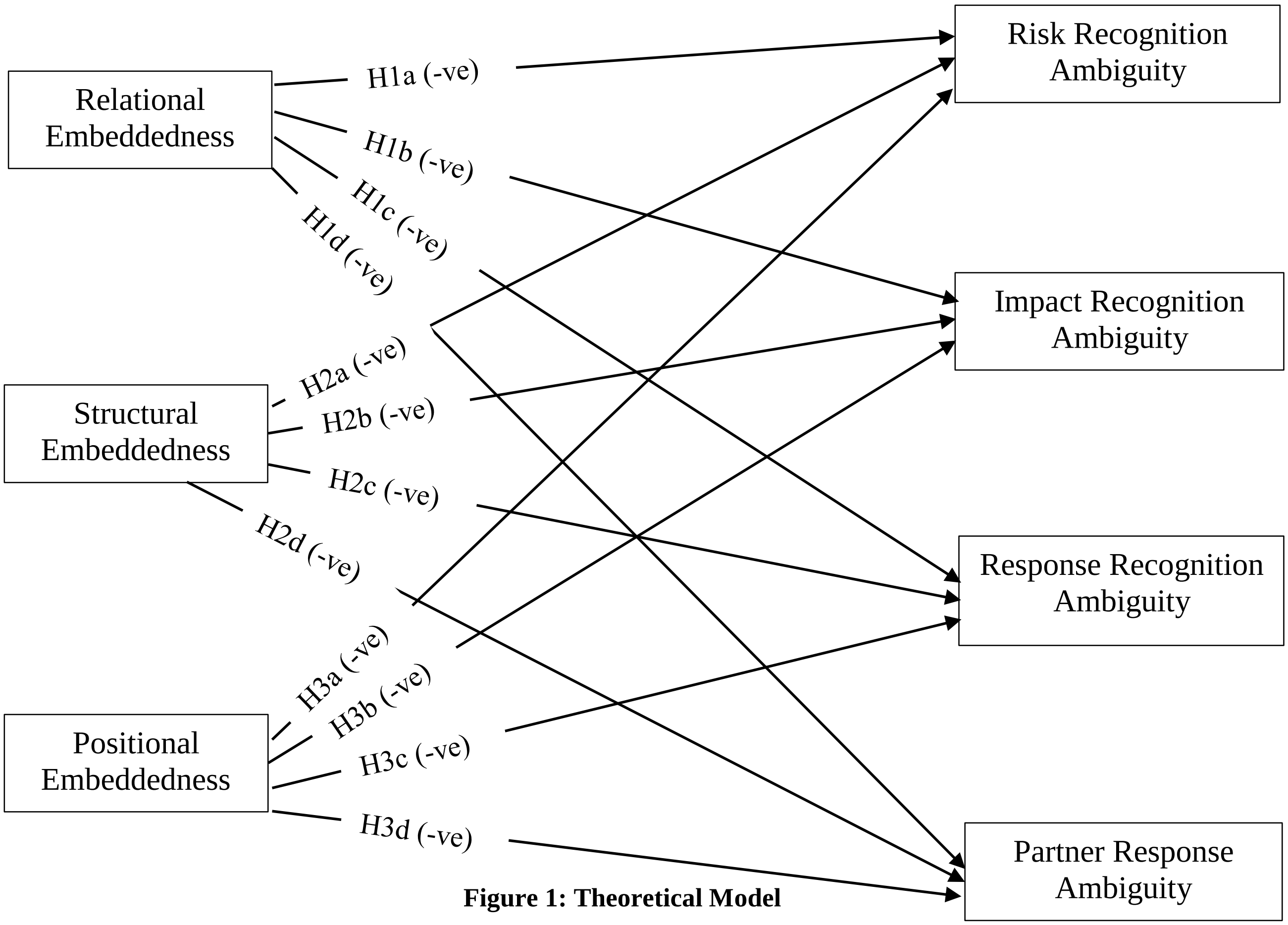

Figure 1: Theoretical Model

To the extent that information and knowledge impact performance, innovation, and sustainable competitive advantage, among others, networks have shown to be an important factor in achieving the prior mentioned outcomes (Ahuja, 2000; Powell, Koput, and Smith-Doerr; 1996). For example, if information is obtained, transmitted, or learned through ties among firms, then the mechanism and efficiency of the transfer depends on the various properties of the network (Hansen, 1999; Krackhardt, 1992). To illustrate, having greater number of ties in a network may provide the focal firm with additional resources for gathering more information. It can also act as an alternate source for validating the information received from multiple sources. Apart from the number of ties between the firms in a network, the strength of these ties can potentially channel the quality of information flow in the network (Levin and Cross, 2004; Reagans and McEvily, 2003). For example, consider few firms in the network that command much of the information as well as the information flow in the network. The importance of strong ties lies in the fact that a firm can potentially extract or gather the same or more information from the network by virtue of the strong and cohesive ties it has with these selected members of the network instead of forming ties with all of the members in the network.

At the same time, consider from the focal firm's perspective a network that is characterized by large number of inter-connected ties, also referred to as high network density. There is a possibility that the large amount of the information transmitted through the network and the information obtained by the focal firm is actually repetitive and, therefore, redundant for the focal firm (Rowley, Behrens, and Krackhardt, 2000; Zaheer and Bell, 2005). It is highly likely that the focal firm will receive information that can be understood and contextualized from a single common perspective. This might deprive the focal firm of a diverse perspective of the event or activity about which the information is being transmitted. Given that information and knowledge – be it the richness, quality, reliability, and authenticity of the information or the flow and integration of information from multiple sources – form an important aspect of supply chain ambiguity, the above discussion highlights multiple facets of a network that can potentially escalate or exacerbate supply chain ambiguity. While a network has the capacity and potential to filter, verify, and validate the information (Bensaou, 1997; Samaddar, Nargundkar, and Daley, 2006) to ultimately influence supply chain ambiguity, the mechanism, as such, can be better understood through different aspects of network embeddedness, namely, relational, structural, and positional embeddedness. The sub-sections below further elaborate on and discuss in detail the hypothesized relationship between different types of network embeddedness and organizational ambiguity.

3.3.1 Relational Embeddedness and Ambiguity

I first examine the relationship between relational embeddedness and risk recognition ambiguity. Firms that share strong relational ties in a network often have a better understanding of and better working relationships with partner firms in the network (Larson, 1992; Uzzi, 1996). This common understanding provides a context for the information being shared in the network that is relevant and useful to the focal firm. Relational embeddedness, hence, acts as a filtering mechanism to screen out irrelevant and trivial information, and makes the information more concise and precise for the focal firm. As one of the major contributors to risk recognition ambiguity is a limited information processing capability (Simon 1976, Tversky and Kahneman, 1986), the act of reducing information vagueness by virtue of the relational ties shared in the network can be a potential extension of the firm's processing capability. In other words, the firm can utilize its relational embeddedness as a resource to enhance its information processing capability. The increased capability allows the firm to be better prepared to understand the potential risk posed by the ongoing events in the supply chain, thereby reducing risk recognition ambiguity. In addition, strong relational ties are conducive for the flow of fine-grained and detailed information (Human, and Provan, 1997; Uzzi, 1996).

Often ambiguity in risk recognition is not due to a complete lack of information but rather to limited and equivocal information (Daft and Macintosh, 1981; March, 1978; March and Olsen, 1975). The possibility of interpreting the information in various ways due to the unspecific and vague nature of the information shared contributes significantly to risk recognition ambiguity. The availability of detailed and fine-grained information increases the richness of the information and also provides a specific context and direction as to how the information should be interpreted (Choo, 1996; Reed and DeFillippi, 1990). As such, strong relational ties provide specific and unequivocal information as well as increasing a firm's information processing capability, which leads to reduced risk recognition ambiguity. Hence, I postulate:

H1a: Firms that exhibit high levels of relational embeddedness with partner firms in a network will have low levels of risk recognition ambiguity.

As disruptions unfold in a supply chain, the focal firm is often bombarded with multiple accounts of the events from various sources (Skipper and Hanna, 2009; Croxton, Garcia-Dastugue, Lambert, and Rogers, 2001). While the firm is in no doubt that the ongoing event poses a significant risk to the firm and the supply chain, the conflicting nature of the rapidly flowing information reduces the firm's ability to decide what the actual gravity of the situation is. The firm has reasons to be skeptical about the information as the various sources will spin or twist the information to serve their own objectives (Lee, Padmanabhan, and Whang, 1997; Manuj and Mentzer, 2008). In this scenario, as the firm is uncertain about the scale and magnitude of the unfolding event, the firm is ambiguous regarding the potential impact the event could have. Strong relational ties shared by the firm allow it to account for the part of the information that can be validated and is reliable (Rowley, Behrens, and Krackhardt, 2000; Powell, Koput, and Smith-Doerr; 1996). Depending on the extent of relational ties shared, the focal firm can communicate the information received about the ongoing event in a timely manner to network members to further authenticate the information (Gulati, 1999). Based on the part of the information that is largely validated by the network, the focal firm can significantly reduce the impact recognition ambiguity associated with the disruption. Hence,

H1b: Firms that exhibit high levels of relational embeddedness with partner firms in a network will have low levels of impact recognition ambiguity.

The extent of relational embeddedness in the network also facilitates, to a varying degree, the accessibility and efficiency of the knowledge transfers (Dyer, 1996; Dyer and Nobeoka, 2000) that can provide the firm with the know-how and strategies to reduce ambiguities related to supply chain disruption response and mitigation strategies. These strategies have often been successfully employed or have been vetted by partner firms in the network. For example, Toyota's success in managing its supply chain disruptions has been largely attributed to its ability to create a highly embedded supplier knowledge-sharing network that allows for the easy diffusion of Toyota's production know-how (e.g., Toyota Production System) and easy exploration and exploitation of the existing know-how that resides in its suppliers. In addition, high relational embeddedness will also promote various means of problem solving approaches (Gulati, 1999; Gulati and Gargiulo, 1999) such as joint problem solving, and cross-functional teams from different firms, thereby reducing response ambiguities for the focal firm.

H1c: Firms that exhibit high levels of relational embeddedness with partner firms in a network will have low levels of response recognition ambiguity.

High relational embeddedness increases trust between firms (Moran, 2005; Rowley, Behrens, and Krackhardt, 2000) and reduces the uncertainties associated with the present and future collaboration and cooperation intentions (Gulati and Gargiulo, 1999). The know-how about other firms' capabilities and competencies combined with strong reliability in the relationships will reduce the ambiguities associated with partner firms' responses in the event of supply chain disruptions. Increased cohesiveness between the firms in a supply network implies that the firm will have a tendency to cooperate and collaborate rather than compete within the network (Choi and Hong, 2002; Dyer and Nobeoka, 2000). Since high relational embeddedness leads to greater cohesiveness between the firms, it also encourages the timely flow of knowledge and information in the network, thereby providing the focal firm with valuable information about any variability in the operational factors such as on-time part delivery variations. Higher levels of trust in dealing with network partners also implies that the partner firm will be more likely to share detailed information of any process variation in production or quality issues that the focal firm might be ambiguous about, thereby reducing the ambiguity. Hence,

H1d: Firms that exhibit high levels of relational embeddedness with partner firms in a network will have low levels of partner response ambiguity.

3.3.2 Structural Embeddedness and Ambiguity

Structural embeddedness refers to the connectedness among the suppliers that comprise the focal firm's network. A highly inter-connected supplier network will be advantageous and conducive for efficient flow of information and knowledge (Gnyawali and Madhavan, 2001; Rowley, Behrens, and Krackhardt, 2000). Additionally, a highly cohesive group of suppliers is characterized by shared goals and objectives (Dyer and Hatch, 2006; Dyer and Nobeoka, 2000). With increasing inter-connectedness, network suppliers are more likely to co-operate and co-ordinate such as they may directly discuss manufacturing and delivery problems, or other issues. Discussion over a common platform among suppliers will allow the presentation of multiple and diverse views on various ongoing situations and bottlenecks in the supply chain. Information and knowledge will flow freely in such discussions among highly inter-connected suppliers. Any situation in the supply chain that emerges with the potential to disrupt the chain in the near-future then can be passed on to the focal firm. The availability of such information for the focal firm, along with the knowledge that the situation was discussed, analyzed, and assessed by the suppliers, will eliminate the need to further scan the network for more information, thereby saving valuable time in reducing risk recognition ambiguity. The information provided to the focal firm will most likely be filtered, relevant, and complete, and there will be a far lower chance of misinterpretation and vagueness. Therefore, structural embeddedness will greatly reduce ambiguity for the focal firm in recognizing risks posed by ongoing or developing situations in the supply chain.

H2a: Firms that exhibit high levels of structural embeddedness with partner firms in a network will have low levels of risk recognition ambiguity.

Supplier firms in a focal firm's network that share significant interconnectedness will recognize their interdependence quite readily and will work to improve rather than undermine the effectiveness of the network (Provan, 1994). The supplier firms will likely realize that any benefits that arise from their collaborative efforts will ultimately be beneficial for them (Dyer and Hatch, 2006; Dyer and Nobeoka, 2000). To illustrate this, any saving in cost through improved process synchronization among suppliers can be passed on to the focal firm, which benefits the whole network through improved sales and reduced lead time. This will lead to more business for the focal firm as well as the network. Similarly, suppliers' connectedness can play a significant role in impact and response recognition ambiguity in a supply chain. Suppliers motivated to protect their own businesses will act together to shield the supply chain from the impact of disruptive events. One such scenario would involve suppliers working together to produce a product or develop a process that the focal firm could not have developed quickly enough on its own in the event of a supply chain disruption.

Owing to Toyota's highly collaborative and interactive suppliers' network, there were few ambiguities in the complete supply network regarding the real threat of a production shut down due to the fire at the supplier's proportioning valve (p-valve) production facility (Nishiguchi and Beaudet, 1998). The supplier was the sole source of p-valves, a crucial brake related component. The fire completely destroyed the production facility, leaving only few days of stock available. A complete shutdown of Toyota plants and that of hundreds of its suppliers seemed unavoidable; however, Toyota's highly interactive and collaborative group of suppliers managed to develop alternate suppliers within the group and contained the disruption. The Toyota manufacturing facility was back to scheduled production after only two days of shutdown. The network ensured that the implications and consequences of the event were clearly known, and the related knowledge was quickly disseminated and understood in the network. The high structural embeddedness among the suppliers not only reduced risk recognition and impact recognition ambiguities, but also minimized response recognition ambiguity by quickly converging to the best option available and acting on it. This efficient knowledge-sharing network exchanged information and resources to develop an alternate source for p-valves within the existing supplier base in few days, whereas identifying a new source and integrating it within the supply chain could have easily taken months for Toyota. Even a temporary, make shift production would have taken at least a week. This situation exemplifies the significance of structural embeddedness in reducing ambiguity in impact recognition and quickly location and acting on a response strategy.

H2b: Firms that exhibit high levels of structural embeddedness with partner firms in a network will have low levels of impact recognition ambiguity.

H2c: Firms that exhibit high levels of structural embeddedness with partner firms in a network will have low levels of response recognition ambiguity.

High structural embeddedness will reduce the possibility of opportunism by supplier firms (Provan, 1994; Sako and Helper, 1998), thereby reducing partner response ambiguity. When suppliers' embeddedness in a network is strong and they are interdependent among themselves and with the focal firm, there is little advantage to behaving opportunistically (Provan and Skinner, 1989). For example, Toyota's suppliers are significantly dependent on Toyota's performance and success in the market place to gain business (Dyer and Nobeoka, 2000), and Toyota is dependent on its suppliers working collaboratively to gain an advantage over its competitors and sell its cars more competitively. Therefore, the suppliers are less likely to behave opportunistically as they would gain little. Also, it is likely with greater supplier-supplier connectedness that suppliers would monitor other supplier firms' actions and inactions in the network. Any opportunistic behavior would most likely be discovered, which would cause a long term negative impact for the opportunistic supplier and possibly the focal firm by reducing its competitiveness. Hence, high structural embeddedness will be effective for the focal firm by ensuring that partner firms behave along the expected lines and not opportunistically.

> *H2d: Firms that exhibit high levels of structural embeddedness with partner firms in a network will have low levels of partner response ambiguity.*

3.3.3 Positional Embeddedness and Ambiguity

A firm that occupies a central position relative to others in a network is postulated to have greater access to information and knowledge, control information accessibility and knowledge flow, and act as a liaison between different members of the network (Borgatti and Li, 2009; Ibarra, 1993). Accordingly, the position a firm occupies will be reflected in its power and status by virtue of its embedded relationships. Firm that enjoy a better position in the network will be suitably placed to access and verify the information they receive as well as the source of information (Burt, 1987; Madhavan, Koka, and Prescott, 1998). To elaborate, a relatively better placed firm in a network acts as a conduit for knowledge and information flow in the network, which allows the firm to compare the information across multiple sources and determine its veracity. Additionally, receiving similar information from multiple sources will increase the richness of information for the focal firm, thereby reducing the chance of missing any vital information. A firm with low positional embeddedness may find itself often lacking timely information about crucial decisions in supply chain. The increased visibility of the network and timely access to information for a relatively centrally embedded firm in the network (Madhavan, Koka, and Prescott, 1998; Zaheer and Bell, 2005) acts as an effective channel for reducing risk recognition ambiguity. For example, any process variation or quality deterioration caused by shifting to low grade raw materials, or other such activities that supplier firms may indulge into for various reasons such as cost reduction, will most likely be detected by the focal firm. Detailed information on the deviation, be it process, quality, or design based, will help the focal firm analyze the potential risk the deviation could pose immediately or in the future. Therefore,

H3a: Firms that exhibit high levels of positional embeddedness with partner firms in a network will have low levels of risk recognition ambiguity.

Supply chains are extensively characterized by complementary components or parts that are manufactured across a supply network and then assembled as a final product. Disruptions that affect the functionality, be it design or process related, of the component have the potential to derail the supply chain. In other words, a component developed through a changed process or design or at an alternate supplier may not exactly resemble the previous component even though it meets the technical and functional requirements. In such a case, higher positional embeddedness for the firm in the network will allow it to visualize beforehand the impact a single change in component at one supplier could have on the rest of the suppliers. It is likely that the supplier that manufactures the component, due to its relatively peripheral position, will lack the vital information on how a seemingly minor change in the component could disrupt the supply chain; however, a centrally placed firm, due to its greater access to the knowledge, will be better situated to assess the impact of the event on the supply chain. For example, consider a small print supplier of labels for a multinational soft drink producer. The labels were printed in a special shade of yellow paper with a specific wood content that was well adapted to the cleaning and filling of the return bottles at another supplier for the soft drink producer (Anderson, Håkansson and Johanson, 1994). Due to the unavailability of the specific yellow paper with the specific wood content, the label supplier informed the soft drink producer of a change in paper. The soft drink producer, owing to its centrally placed position, was unambiguous on the impact this change would have on its supply chain as the cleaning and filling supplier's equipment was calibrated for the special paper previously used. The new label, though capable of meeting all the functional requirements, would create disruptions at the cleaning and filling supplier as the new label could hamper the speed and functioning of the equipment and would thus be unacceptable. In such a case, a relatively better positioned firm in the network would be able to reduce ambiguity regarding the impact of the disruptive supply chain event.

H3b: Firms that exhibit high levels of positional embeddedness with partner firms in a network will have low levels of impact recognition ambiguity.

In supply chains, firm synchronize and adapt their activities relative to each other in order to support the smooth functioning of the chain (Choi and Krause, 2006; Flynn, Huo, and Zhao, 2010). Firms adapting activities in several relationships in the supply network create resources that reside in the network (Borgatti and Li, 2009; Zaheer and Bell, 2005). Given the complementary nature of the network, these resources are most likely to be unlinked to those engaged in the relationship and may also have value and implications for relationships that are connected or engaged to those firms or any other firm in the network (Chen, Paulraj, and Lado, 2004; Defee and Stank, 2005). For example, a focal firm may conceptualize, develop, validate, and implement manufacturing flexibility – namely, volume and mix flexibility – with a selected group of suppliers as a response mechanism to supply chain disruptions. In the event of supply chain disruptions, the focal firm will be unambiguous regarding the suitability, effectiveness, or relative importance of the response mechanism with respect to the disruptive event. Depending on the positional embeddedness of the firm, the firm may be able to extend or utilize resources from other relationships to reduce response recognition ambiguity.

H3c: Firms that exhibit high levels of positional embeddedness with partner firms in a network will have low levels of response recognition ambiguity.

A firm that occupies a relatively central position in a network significantly controls the flow of information and knowledge in the network (Ibarra, 1993; Madhavan, Koka, and Prescott, 1998). It also acts as the reference firm that the supplier firms contact in order to access information or acts as a conduit for the flow of information to other firms in the network (Choi, Dooley, and Rungtusanatham, 2001). As a relatively central firm congregates control over suppliers' ability to communicate and coordinate in the network, it exerts power and influence among the partner firms in the network (Vurro, Russo, and Perrini, F. (2009). With its ability to influence suppliers, the focal firm can extract favorable behavior as required. Thus, there will be little ambiguity regarding the partner response. Additionally, high positional embeddedness can help firms gather reliable and trustworthy information about potential and existing suppliers' capabilities (Gulati, 1999; Gulati and Gargiulo, 1999). A centrally embedded firm commands a better view of the network. It is also more likely to establish new favorable relationships quickly as firms will prefer to identify themselves with relatively centrally placed firms in the network (Anderson, Håkansson and Johanson, 1994). As such, the environment will be conducive and favorable for the focal firm's collaborate with new suppliers in its attempts to reduce partner response ambiguity.

H3d: Firms that exhibit high levels of positional embeddedness with partner firms in a network will have low levels of partner response ambiguity.

4. Methodology

The following section discusses in detail the research methodology employed for the purposes of this study, while the sub-sections describe the process of the instrument development, survey deployment, and analysis. The first sub-section explains the approach to construct operationalization and scale selection for the survey. The second sub-section details the sample selected for the purposes of the study such as the target industry, unit of analysis and respondents' qualifications. The third sub-section is concerned with sample demographics analysis, whereas the fourth sub-section discusses in detail the descriptive statistics, validity, and reliability of the constructs. The fifth and the final sub-section provides the details of the test for hypotheses.

4.1 Construct Operationalization

This study develops instruments for construct measurement following established procedures. I followed the traditional multi-step process to develop and subsequently validate the measurement instruments. Initially, I conducted an extensive review of the inter-firm networks, strategies, operations, and the supply chain literature to identify relevant constructs and measurement items that could be utilized for the purpose of this study. As discussed, I primarily hypothesize that supply chain networks are the key drivers of ambiguity associated with the recognition and mitigation of supply chain disruptions. All items for the constructs in the model, including the dependent and independent constructs as well as the controls, were developed using a 7-point Likert scale where 1 represents '*strongly disagree'* and 7 represents '*strongly agree'.* The sample characteristics, such as the firm size and type-of-industry, were developed using a mixture of categorical and interval scales, and are explained in the relevant sections below. I describe in detail the instrument development process below, starting with the three embeddedness constructs that tap into the network properties relevant to the supply chain.

Relational Embeddedness highlights the significance of a firm's cumulative experience and the strength of its relational ties built on cooperation and co-ordination with its supplier network. A firm's overall experience is founded on various aspects of its relationship with its suppliers, including non-transactional interactions, mutual assistances, and joint operational and strategic commitments (Gulati 1995; Shan, Walker and Kogut, 1994). The practitioner literature reinforces the idea that executives that interact often with suppliers across multiple forums exhibit more cohesive ties with their suppliers (Bensaou, 1999). Hence, and drawing on prior studies (Gulati and Gargiulo, 1999), relational embeddedness was operationalized using five items that gauged the extent to which the executives at the focal firm interacted with their counterparts in supplier firms (including in-business as well as non-business settings), discussed future supply chain plans and major operational decisions with suppliers, and provided technical and operational assistance, as well as gauging how long the executives had known their suppliers.

Structural Embeddedness is primarily a measure of the extent to which the suppliers in the focal firms' supply networks are linked to each other through shared supply chain practices, and knowledge and information sharing. Such interconnectedness between the members of the supply network has been argued to be structurally different from the relations that the focal firm itself has with its suppliers and can be gauged by the extent of the collaborative activities amongst the firms in the network (Ahuja, 2000; Shan, Walker, and Kogut, 1994; Powell, Koput, and Smith-Doerr; 1996). Further, while discussing the network context of buyer-supplier relationships, scholars (Anderson, Hakansson and Johanson, 1994; Choi and Krause, 2006) have also emphasized the role of strategic discussion among suppliers as an element of network connectedness. Drawing on the literature above, and specifically Gulati and Gargiulo (1999), I operationalized structural embeddedness by tapping into the extent to which the suppliers coordinated in designing and developing new parts, products, and processes; the extent to which the suppliers participated in joint problem solving and operational discussions; the extent to which suppliers interacted with each other to discuss strategic issues; and the extent to which the suppliers initiated and participated in vendor meetings.

Positional Embeddedness principally measures the extent to which the focal firm enjoys a position of prominence and importance within its supply network, wherein a significant amount of key information and ideas flowing through the network is influenced and controlled by the focal firm. I adapted the items proposed, developed, and subsequently validated by Anderson, Håkansson, and Johanson (1994) in their study of network properties in the context of buyer-supplier relationships. Further, positional embeddedness can also be captured through how much the supplier management policies adopted by the focal firm are influential and the focal firm ability to leverage its position to effect suppliers decision making processes in its network (Choi and Hong, 2002; Choi and Krause, 2006). Based on the above literature, the items were adapted to tap into the focal firm's ability to attract the most competent suppliers in the industry, the reputation of its supply chain practices and views in the industry; its capability to influence key technological developments and set the future trends, and its ability to assert its position as the major player in the industry.

The measures associated with ambiguity in recognizing and dealing with supply chain disruptions were adapted from prior studies to the context of my research. I measured *risk recognition ambiguity* by using the theoretical precepts provided by Milliken (1987), and adapted the relevant instruments developed in prior studies (Ashill and Jobber, 2010; Bakshi and Kleindorfer, 2009; Van der Vorst & Beulens, 2002). The construct used items meant to gauge the ability of the focal firm to anticipate and identify supply chain disruptions; its ability to recognize internal and external events that have the potential to cause disruptions; and its ability to recognize the nature and characteristics of the disruptions as they manifest. *Impact recognition ambiguity* was measured with four items that reflect the focal firm's ability to accurately assess and correctly estimate the losses caused by supply chain disruptions such as financial loss, operational loss, market share loss, and brand devaluation. The items for impact recognition ambiguity were drawn from prior studies that examined the impacts of supply chain disruptions (Hendricks and Singhal 2003; Hendricks and Singhal, 2005; Norrman, and Jansson, 2004).

Response recognition ambiguity relates to uncertainty on the part of the focal firm in acting quickly and effectively by deciding on the response options in the event of supply chain disruptions. The level of response recognition ambiguity was measured using four items that capture the firms' ability to converge quickly on a set of response options in the event of a disruption, and to identify, implement, and evaluate a specific and appropriate response strategy from among the available set of options (Pagh, and Cooper, 1998; Tarnef, 2011; Yang and Yang, 2010). *Partner response ambiguity* measures the understanding of and the confidence that the focal firm has in its suppliers' capacity and readiness to withstand supply chain disruptions. The inability to assess supplier capability to deal with disruptions, including financially and operationally, is a major element of uncertainty for firms experiencing and responding to supply disruptions. Additionally, suppliers' readiness to co-operate in the event of a major disruption can also increase the focal firms' uncertainty in responding to disruptive events. With relevant inputs from the literature (Artz, and Brush, 2000; Hawkins, Wittmann, and Beyerlein, 2008;

Leuthesser, 1997), I measured partner response ambiguity using four items that reflect the focal firm's understanding of suppliers' response strategies to disruption, its ability to correctly anticipate suppliers' operational and financial capability to withstand disruptions, and its ability to anticipate the extent of supplier cooperation and collaboration in the event of supply chain disruptions.

Control variables. Competitive intensity was measured by three items adapted from Bode et al. (2011) and Jaworski and Kohli (1993). The three items taps into the ability to offer a unique, inimitable product, the intensity of competition, and the capability to maintain market position. The level of mix flexibility was captured by asking respondents to assess the extent to which different varieties and categories of product can be manufactured simultaneously without major changeover. Similarly, volume flexibility was measured with items that indicate the efficiency, profitability, and feasibility of production volume change. Both the mix flexibility and volume flexibility measures were adapted from Braunscheidel and Suresh (2009) and Zhang *et al.* (2003). Technological turbulence and manufacturing complexity were measured using three items adapted from Lee and Johnson (2010) and Bozarth et al. (2009), respectively. Firm size was measured in three different ways: the sales revenue per year of the focal firm, the procurement budget of the focal firm, and the number of employees in the focal firm. The manufacturing firm type and geographical distribution of the core supply base were coded as categorical variables.

4.2 Questionnaire Design and Administration

The sample frame for our study consisted of 1,655 firms from the 'MintAmericas' business directory. These firms were selected to reflect the wide range of manufacturing sectors in North America, namely, Motor Vehicles and Transportation Equipment Manufacturing, Electronics and Electrical Manufacturing, Chemicals and Petrochemicals Manufacturing, Industrial Equipment Manufacturing, and Food and Beverages Manufacturing. The sample firms were drawn from a wide range of manufacturing industries within the two-digit NAICS codes; 31, 32 and 33; which cover the entire manufacturing industry, thereby targeting a diverse range of purchasing and supply chain managers managing a wide range supply chains types.

For each firm, managers with significant seniority and experience in the field of supply chains, logistics, purchasing, operations, and procurement were identified. Generally, senior managers, directors, departmental heads, vice-presidents, and presidents were the respondents for this study. Using participants with significant seniority in the organizational hierarchy coupled with decision making authority and responsibility, this sample frame facilitated the study of a manager's understanding of supply chain risk, its impact, and response strategies in the event of supply chain disruptions. Prior studies have indicated that samples involving managers in higher positions in the firm facilitate a more comprehensive understanding of the supply chain (Frohlich and Westbrook, 2001; Braunscheidel and Suresh, 2009).

The previous supply chain literature has mainly focused on and studied buyer-supplier relationships as isolated dyadic relationships. These studies have provided rich insights into and understanding of critical dyadic characteristics such as types of governance mechanisms, buyer-supplier integration, and performance outcomes. However, as discussed by Anderson, Hakansson and Johanson (1994), a given dyadic relationship is influenced by and also influences other relationships directly or indirectly both for the buyer as well as the supplier. Owing to the interconnected of the relationships and the potential for specific dyadic pairs to influence other relationships operating in their proximity, many researchers have argued in favor of examining the broader collective of buyer-supplier connections, referred to as the supply network or the supply web, instead of focusing on isolated relational dyads (Choi and Krause, 2006; Lamming et al., 2000; Straut et al., 1998).

Further, both widely implemented practitioner best practices as well as recent studies in the supply chain literature have alerted us to the phenomenon of supplier base consolidation or supplier rationalization. The practice of supplier base consolidation involves the identification of a smaller number of key suppliers, as opposed to negotiating and transacting with a larger number of suppliers, which allows the buying firms to develop, implement, and streamline their key supply chain policies on a more uniform basis. In addition, other researchers have treated the aggregated collection of individual supplier relationships as singular complex adaptive systems (Neiger, Rotaru and Churilov, 2009). Hence, I measure the constructs and analyze the results in my study by using the *core supplier base*, which is the overall network of suppliers with which the focal firm usually interacts, as my unit of analysis. This definition of core supplier base is in line with Choi and Krause's (2006) suggestion that care should be taken to include only those suppliers that are actively managed by the focal firm in the core supplier base.

Although the notion of supply chains as supply networks has recently garnered significant interest from scholars in the supply chain field, few studies have actually analyzed and operationalized supply chain networks as perceived by a firm. The operational measures of inter-firm networks as developed in the mainstream network literature, such as joint ventures, R & D collaborations, and vertical integration, do not translate well or provide adequate guidelines for conceiving buyer-supplier relationships as networks (Borgatti and Li, 2009). As a result, I build on the key notions provided by Anderson, Håkansson, and Johanson (1994) to view and operationalize the core supplier base primarily as a network conceived by the focal firm, and hence measure and analyze the properties of the supplier network as they are perceived by the focal firm. The respondents in this study were asked to identify their core supplier base as the group of suppliers with which the respondent's firm transacted most frequently for high value products and routinely managed, planned, monitored, coordinated, and communicated with. All the survey questions related back to the core supplier base that the respondent was asked to identify upfront.

Finally, the respondents were asked to base their answers on their cumulative experiences from all previous supply chain disruptions in the last 24 months (e.g. Bode et al., 2011). This was done to negate the potential inability of the respondent to recall any one particular disruption and the specifics associated with that particular event. It was also done to take into consideration that any future responses to supply chain disruptions will primarily be the result of the decision maker's overall experience with previous supply chain disruptions rather than the impact or outcomes associated with one particular event in the past.

The questionnaire for this study was administrated through a web-based survey. Of the 1655 firms targeted in the survey in total, 175 professionals provided their complete responses, resulting in a response rate of 10.6% for the study. However, a total of 309 contact emails were returned as invalid, retired, in a different/irrelevant position, or having switched companies, and hence were removed from the potential target list of the survey. This adjusted figure yields an effective response rate of 13%, which is comparable to recent empirical studies in the field of supply chain risk management (Bode et al., 2011; Braunscheidel and Suresh, 2009; Ellis, Henry and Shockley, 2010).

To ensure there was no systematic non-response bias influencing the pattern of responses, I applied two different tests. In the first, I tested for significant differences between early and late respondents, as late respondents can be considered as a proxy for non-respondents (Armstrong and Overton, 1977). The responses were divided into four quartiles and the responses of the first quartile were compared to those of the last quartile. Chi-squared tests were done to test for significant differences between early and late respondents. I compared the sales revenue (chi-squared = 7.26, p = 0.12), procurement budget (chi-squared = 3.96, p = 0.56), and number of employees (chi-squared = 4.47, p = 0.65) for both early and late respondents. The results indicated no significant difference between early and late responses. The second method tested for significant differences between respondents and the non-respondents in the mailing list. A t-test was conducted using the firms' annual operating revenue and total number of employees as provided by the MintAmericas database. As no significant differences were found, it can be concluded that the data is not influenced by non-response bias.

A concern with the single-respondent, questionnaire-based measurement is the existence of common method bias or common method variance (CMV). The existence of common method bias was assessed using Harmon's one factor test and the marker variable test (Podsakoff et al., 2003). I conducted an exploratory factor analysis with the principal components extraction method and found that the factors extracted accounted for 73.59% of the total variance and the first component accounted for only 25.91% of the variance. There was no single dominant factor and the extraction resulted in 12 factors with Eigen values greater than 1. Hence, it was concluded that CMV was not a concern in this data. To conduct the marker variable test (Lindell and Whitney, 2001; Malhotra et al., 2006) bivariate correlations of the independent, dependent, and control constructs were compared against key marker variables (sales revenue, procurement budget, and total number of employees for the responding firms). Factor scores as calculated from exploratory factor analysis were used to assess the correlations. As the highest correlation was only 0.3 between the procurement budget of the firm and impact recognition ambiguity, and as the majority of the correlations were below 0.2, common method variance was judged to be not a problem for the study.

4.3 Sample Demographics

The demographics of the respondents' profile, firm, and industry is summarized in table 6. The categorization of the size of the firms by various parameters, namely sales revenue, procurement budget, and number of employees as shown in Table 6 facilitates a better understanding of the responding firms' distribution across the manufacturing industry. The majority of the firms indicated revenue in the range of 1 to 50 Billion dollars. The procurement budget category shows that firms with budgets of less than 100 Million to budgets greater than 1 Billion were adequately represented in the responses. The almost even representation of the various number of employee categories, with the highest at 29 percent for the 10,001 - 50,000 category, indicates that the sample reasonably represents the intended population.

Classification	% Respondents	Classification	%Respondents	Classification	%Respondents
Firm Size - Revenue in $		**Firm Size - Procurement in $**		**Firm Size - Number of Employees**	
< 250 Million	10.9%	< 100 Million	18.9%	< 500	8.6%
250 - 500 Million	8.0%	101 - 250 Million	12.0%	501 - 2000	20.0%
501 Million - 1 Billion	10.9%	251 - 500 Million	20.0%	2001 - 5000	16.0%
1 - 50 Billion	65.1%	501 Million - 1 Billion	14.3%	5001 - 10,000	12.6%
>50 Billion	5.1%	> 1 Billion	34.9%	10,001 - 50,000	29.1%
				> 50,000	13.7%

Table 6: Profile of Respondents by Firm Size

As previously stated, executives in senior decision-making positions were argued to be ideally informed about key supply chain decisions. The percentage of responses from participants with a profile (Table 7) such as chief procurement officer, general manager, vice-president, director, senior manager, or manager indicate that the responses received were from practitioners who had sufficient seniority to understand and decide on the supply chain management practices followed by their firm. The highest number of responses were received from managers, closely followed by those from directors. While managers represent approximately 38 percent of the respondents, the directors and senior directors combined account for approximately 28 percent. Table 7 also shows that all the major types of manufacturing firms were adequately represented by the responding firms in varying degrees, with the lowest being 9 percent for the food and beverage manufacturers. Manufacturing firms other than the five categories listed here constitute 32 percent of the responding firms.

Classification	%Respondents	Classification	%Respondents
Respondent position		**Type of manufacturing firm**	
Chief - Operations/Procurement	1.1%	Motor Vehicles & Transportation Equipment	20.6%
General Manager	2.3%	Chemicals & Petrochemicals	13.7%
Vice-President	9.7%	Electronics & Electrical	12.0%
Senior Director	8.0%	Food & Beverages	9.1%
Director	20.0%	Industrial equipment	12.6%
Senior Manager	9.7%	Others	32.0%
Manager	37.7%		
Others	11.4%		

Table 7: Profile of Respondents by Designation and Industry Type

Of the total 159 respondents, approximately 50 percent indicated that the geographical distribution and location of their firm's core supplier base was either local or mostly limited to North America, whereas the reminder identified their core suppliers as being located globally. Additional demographics of interest, given the unit of analysis of our survey was the core supplier base, are that 61% of the respondents indicated that their firm had multiple manufacturing locations with centralized purchasing and a centrally managed core supplier base, and approximately 30% stated that they had multiple manufacturing locations but with decentralized purchasing and a locally managed core supplier base; the rest were single manufacturing units with a co-located purchasing group. The distribution of core suppliers by size for the responding firms is shown in figure 2. Table 8 summarizes the geographical distribution of the core supplier base for the respondents of this study.

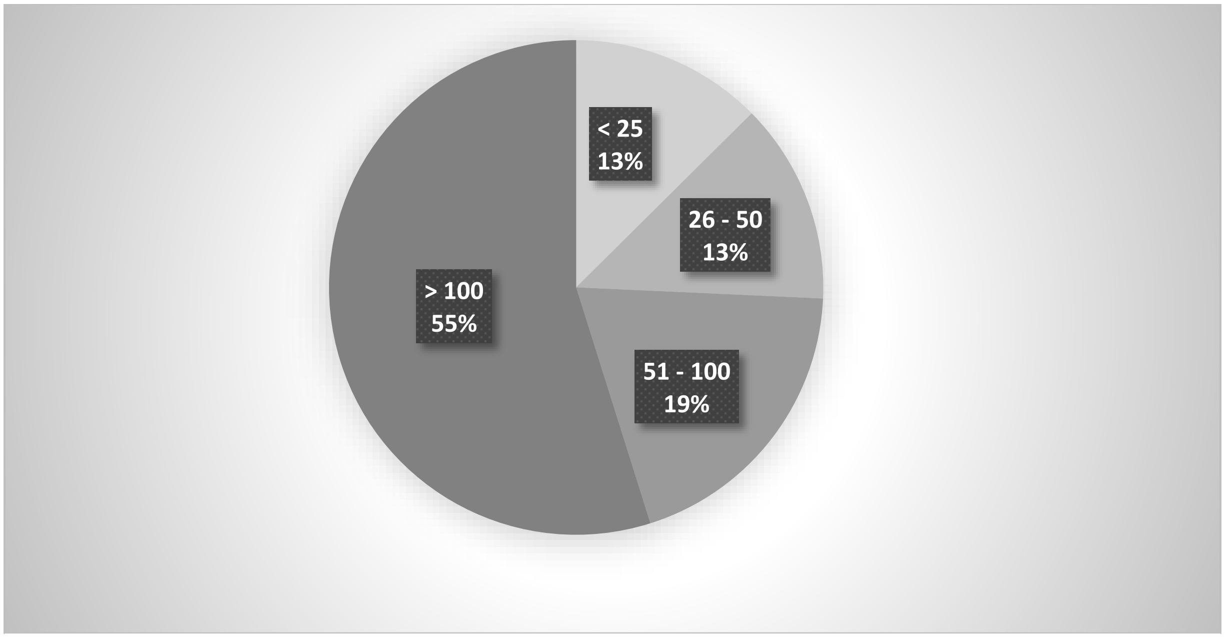

Figure 2: Profile of the 'Size of the Core Supply Base' of the Respondents

Classification	%Respondents
1. Geographical distribution of core suppliers	
Local/Regional	4.0%
National/North American	45.7%
Global	50.3%
2. Location of operating facility and purchasing group	
Single manufacturing location with co-located purchasing group	9.1%
Multiple manufacturing locations with centralized purchasing and centrally managed core supplier base	61.1%
Multiple manufacturing locations with decentralized purchasing and locally managed core supplier base	29.8%

Table 8: Geographical Distribution of Core Suppliers and Respondents' Firm

Additional demographics of interest for the responding firms are reported in Table 9, Table 10, and Table 11. Approximately half of the respondents indicated following major supply chain practices such as Just-in-Time (JIT) or Total quality management (TQM) to some extent in conjunction with their core suppliers. The data (Table 11) also shows that on average, 65 percent of the firms procure direct manufacturing components, both specialty and commodity, from their core supplier base. It leads to an interesting observation that a focal firm mostly considers their core supplier base to be suppliers with whom they transact for components that are consumed as a part of the final product.

Employ the following practices in conjunction with core suppliers:	Proportion of firm responding		
	Not at all	To some extent	To a great extent
Just-in-time (JIT)	14.9%	55.4%	29.7%
Total quality management (TQM)	6.9%	42.3%	50.9%
Vendor Managed Inventory (VMI)	17.1%	59.4%	23.4%
Continuous Replenishment Program (CRP)	26.9%	51.4%	21.7%
Collaborative Planning, Forecasting and Replenishment (CPFR)	22.9%	46.9%	30.3%

Table 9: Usage of supply chain management practices

Use the following to transact with core suppliers:	Proportion of firm responding		
	Not used at all	Used to some extent	Used to a great extent
Traditional EDI (Electronic Data Interchange) Systems	18.3%	44.6%	37.1%
Web Enabled EDI (Electronic Data Interchange) Systems	32.0%	40.6%	27.4%
Internet Based Procurement Systems	41.1%	38.9%	20.0%

Table 10: Profile of transactional platform use

Procure the following from core suppliers:	Proportion of firm responding		
	Not at all	To some extent	To a great extent
Specialty Direct Manufacturing Inputs	6.3%	27.4%	66.3%
Commodity Direct Manufacturing Inputs	6.9%	30.9%	62.3%
Specialty Indirect Inputs	20.6%	52.6%	26.9%
Commodity Indirect Inputs	19.4%	50.9%	29.7%
MRO (Maintenance, Repair, and Operating) Supplies	16.0%	42.9%	41.1%

Table 11: Types of material procurement

4.4 Measurement Quality

As a few constructs and their items were adapted and applied to the context of the present study without having been validated in the context of the present study before, exploratory factor analysis was performed to analyze the loading of the measurement items onto the intended constructs. Prior to the extraction of factors, Kaiser-Meyer-Olkin (KMO) Measure of Sampling

Adequacy and Bartlett's Test of Sphericity were used to assess the suitability of the data set for exploratory factor analysis. A KMO index greater than 0.5 is generally considered suitable for exploratory factor analysis. The criteria for Bartlett's Test of Sphericity is that it should be significant ($p < 0.05$) for exploratory factor analysis to be appropriate. The analysis of the data provides a KMO index ratio of 0.836 and Bartlett's Test of Sphericity was significant at a level of 0.001. With no major concern regarding the suitability of the data for exploratory factor analysis, an EFA with maximum likelihood extraction and varimax rotation were employed. A detailed table with the loadings on various components can be found in Appendix II. The results suggest that the factor structures proposed are consistent with the data. The extraction resulted in 12 components, which is equivalent to the number of constructs in our study. One item each for relational embeddedness (RE1) and partner response ambiguity (PRA4) had poor loadings; however, they were retained pending further confirmatory examinations of the measurement model. In addition, one of the items of partner response ambiguity (PRA1) loads on multiple components. The item was retained within the partner response ambiguity variable for conceptual reasons.

To assess the psychometric properties of the scale, confirmatory factor analysis was performed. As recommended by Anderson and Gerbing (1988), to perform the confirmatory factor analysis, I analyzed the measurement model using AMOS 20.0. Overall, the model provides a good fit (Relative chi square = 1.49, CFI = 0.91, IFI = 0.91, TLI = 0.9, RMSEA = 0.05). The relative chi square was below 3.0, which is the acceptable limit. The CFI, IFI, and TLI were above the recommended threshold of 0.9 (Hu and Bentler, 1999; Bode et al., 2011; Wong, Boon-Itt, and Wong, 2011). At 0.05, RMSEA is within the acceptable limit (less than 0.08). Based on these values, it can be concluded that the measurement model provides an adequate fit to the data (Wagner, Grosse-Ruyken, and Erhun, 2012; Hair et al., 1995; Steiger, 2007).

The factor loadings, squared multiple correlation (SMC), and t-values are listed in Table 12. The items for the constructs can be found in Appendix I. Item RE1 of relational embeddedness and PRA4 of partner response ambiguity have factor loadings and SMC less than or equal to 0.35 and 0.2, respectively. This further reinforces the EFA result that indicate poor loadings of these items onto the intended construct. As the poor loadings of these items were further evident from the confirmatory factor analysis, the items were dropped from the study.

There are differences in opinion regarding the CFA cross-validation of the factor structure that is derived from the EFA. The literature shows instances in which CFA is carried out on a new data set collected independently of the data used to derive the factors for EFA (Han, Back, and Barrett 2010; Richins and Dawson, 1992). However, scholars have argued that the application of EFA and CFA to two different data sets, collected independently, to derive and subsequently validate the extracted factor may be prone to methodological constraints such as the incomparability of EFA and CFA (Van de Vijver and Leung, 1997; Van Prooijen and Van Der Kloot, 2001). The incomparability of EFA and CFA results may arise due to differences in sample demographics and data collection strategies, among others. To account for the divergent views and opinions, I randomly split the data set into two different sets with approximately equal sample sizes. One data set was used for exploratory factor analysis, whereas the second set was used for confirmatory analysis. The EFA result obtained from the randomly generated data set suggests a similar trend to the EFA result obtained from the original data set. It indicated poor loadings for items RE1 and PRA4 on relational embeddedness and partner response ambiguity.

Variable	Items	*b*	SMC	t-value	Variable	Items	*b*	SMC	t-value	Variable	Items	*b*	SMC	t-value
Relational Embeddedness	RE1*	0.35	0.12	3.98	Structural Embeddedness	SE1	0.93	0.87	9.62	Positional Embeddedness	PE1	0.81	0.66	9.55
	RE2	0.53	0.28	5.67		SE2	0.94	0.88	9.66		PE2	0.73	0.54	8.76
	RE3	0.75	0.56	7.18		SE3	0.69	0.47	7.75		PE3	0.66	0.43	7.88
	RE4	0.72	0.52	7.04		SE4	0.61	0.37	7.07		PE4	0.59	0.35	7.17
	RE5	0.62	0.38	---		SE5	0.62	0.39	---		PE5	0.71	0.50	---

b = standardized regression weights (factor loadings); SMC = Squared multiple correlations

Variable	Items	*b*	SMC	t-value	Variable	Items	*b*	SMC	t-value	Variable	Items	*b*	SMC	t-value
Risk Recognition Ambiguity	RRA1	0.79	0.62	9.30	Impact Recognition Ambiguity	IRA1	0.91	0.82	10.01	Response Recognition Ambiguity	RSA1	0.94	0.89	15.12
	RRA2	0.81	0.65	9.48		IRA2	0.92	0.84	10.08		RSA2	0.88	0.78	13.80
	RRA3	0.73	0.53	8.70		IRA3	0.65	0.42	7.69		RSA3	0.83	0.69	12.65
	RRA4	0.70	0.48	---		IRA4	0.65	0.43	---		RSA4	0.80	0.64	---

b = standardized regression weights (factor loadings); SMC = Squared multiple correlations

Variable	Items	*b*	SMC	t-value	Variable	Items	*b*	SMC	t-value	Variable	Items	*b*	SMC	t-value
Partner Response Ambiguity	PRA1	0.87	0.75	4.04	Volume Flexibility	VF1	0.88	0.77	11.04	Mix Flexibility	MF1	0.77	0.59	8.59
	PRA2	0.77	0.59	3.96		VF2	0.89	0.79	11.12		MF2	0.74	0.55	8.45
	PRA3	0.88	0.77	4.04		VF3	0.73	0.53	---		MF3	0.76	0.57	---
	PRA4*	0.31	0.10	---										

b = standardized regression weights (factor loadings); SMC = Squared multiple correlations

Variable	Items	*b*	SMC	t-value	Variable	Items	*b*	SMC	t-value	Variable	Items	*b*	SMC	t-value
Technological Turbulence	TT1	0.82	0.68	11.36	Competitive Intensity	CI1	0.42	0.17	4.70	Manufacturing Complexity	MC1	0.53	0.29	6.07
	TT2	0.92	0.85	12.20		CI2	0.66	0.44	6.46		MC2	0.70	0.49	7.37
	TT3	0.77	0.59	---		CI3	0.90	0.81	---		MC3	0.82	0.67	---

All coefficients were significant at the 0.05 level.
b = standardized regression weights (factor loadings); SMC = Squared multiple correlations
Note: Asterisk items dropped from actual study
Table 12: Psychometric properties of items

The EFA result was further validated when the items RE1 and PRA4 exhibited low factor loadings onto the intended construct in the confirmatory analysis with the second set of data. This suggests that EFA and CFA with both methods – using the same data set first to perform EFA and then conduct CFA or dividing the data set into two randomly generated sets with equal sample sizes to perform EFA and CFA – yield similar results.

The reliability of the scales was assessed using Cronbach's alpha, average variance extracted (AVE), and composite reliability (CR) scores (Table 13 & 14). As reported in table 13, all Cronbach's alpha values and composite reliability scores exceed or are at the 0.7 cutoff established in the literature. In addition, the factor loadings varied from 0.31 to 0.94 and were

Constructs	Mean	S.D.	Cronbach's Alpha	Composite Reliability
Relational Embeddedness	4.7	1.1	0.74	0.75
Structural Embeddedness	3.6	1.4	0.88	0.88
Positional Embeddedness	4.3	1.2	0.82	0.83
Risk Recognition Ambiguity	3.3	1.1	0.84	0.84
Impact Recognition Ambiguity	3.3	1.2	0.87	0.87
Response Recognition Ambiguity	2.8	1.1	0.92	0.92
Partner Response Ambiguity	3.3	1.2	0.87	0.88
Competitive Intensity	4.8	1.0	0.70	0.71
Volume Flexibility	4.7	1.3	0.87	0.87
Mix Flexibility	4.9	1.4	0.80	0.80
Technological turbulence	4.0	1.5	0.88	0.88
Manufacturing Complexity	4.3	1.3	0.72	0.73

Table 13: Descriptive Statistics & Reliability of Constructs

significant ($p < 0.05$). As such, it can be concluded that the convergent validity of the multi-item scales are adequate (Anderson and Gerbing, 1988; Fornell and Larcker, 1981). The Cronbach's alpha value greater than 0.7 indicates that the items have adequate reliability (Nunnally, 1978). The discriminant validity of the construct was assessed by conducting the variance-extracted test. This test involves comparing the square root of the average variance extracted for a construct to the correlation between that construct and every other construct. Discriminant validity is demonstrated if the square root of the variance-extracted estimate is higher than the correlations

(Barclay et al. 1995). Table 14 shows that the discriminant validity is supported for all the constructs.

Constructs	1	2	3	4	5	6	7	8	9	10	11	12
1. Relational Embeddedness	**.66**											
2. Structural Embeddedness	.50	**.77**										
3. Positional Embeddedness	.46	.43	**.70**									
4. Risk Recognition Ambiguity	-.43	-.34	-.43	**.76**								
5. Impact Recognition Ambiguity	-.33	-.21	-.43	.56	**.79**							
6. Response Recognition Ambiguity	-.28	-.08	-.40	.52	.64	**.87**						
7. Partner Response Ambiguity	-.38	-.29	-.40	.66	.62	.55	**.84**					
8. Competitive Intensity	.13	.04	.24	-.22	-.22	-.27	-.14	**.70**				
9. Volume Flexibility	.21	.13	.43	-.29	-.31	-.37	-.31	.03	**.84**			
10. Mix Flexibility	.07	.00	.13	-.19	-.14	-.24	-.17	.05	.32	**.76**		
11. Technological turbulence	.17	.15	.30	-.21	-.22	-.14	-.22	.23	.28	.28	**.84**	
12. Manufacturing Complexity	.22	.24	.29	-.05	-.01	-.04	-.06	.02	.17	.24	.38	**.70**

Note: Square root of the variance-extracted for the constructs are on the diagonal; correlations are off-diagonal

Table 14: Establishing Discriminant Validity

4.5 Model Estimation and Results

Prior to estimating the models, the data were tested for non-normality and outliers. Skew and kurtosis values were used to assess non-normality. As shown in Appendix III, skewness and kurtosis do not appear to be significant problems in the data set. Although a few items in the data exhibit minor skewness and kurtosis, the deviation, depending on whether the intended conclusion is about the population and its parameters or only about the relationship between certain variables, might or might not affect the validity of the results. In this case, as there is no intention to draw conclusions about the actual population characteristics because the focus is only on the significance of relationship between the variables, this minor departure from the normality does not pose a major threat to the conclusions drawn based on this data set. In addition, as the study is concerned only with the significance level of the path coefficients, the minor departure from normality can be justifiably disregarded.

We estimated our causal models and our hypotheses using the ordinary least square (OLS) estimation method. In order to perform the regression, we computed the mean for each construct based on the summated mean values of the items. The sum score method of construct score calculation is desirable as the scales used to collect the data were previously untested. Hair et al. (1995) have also suggested using the mean summated score method when new measures are developed and replicability is desired. Before estimating the model, I analyzed the data to verify that the assumptions of regression were not violated. The assumptions underlying linear regression are: 1) the residuals are normally distributed; 2) there is a constant variation (homoscedasticity) of the residuals against the independent variables; and 3) there is multicollinearity among the set of independent variables. The first assumption was assessed by visually analyzing the standardized residual plot for each of the dependent variables. The residuals were normally distributed without any apparent outliers. An examination of the plots of the residuals against the independent variables did not cause any concern regarding the violation of the homoscedasticity of the residuals. I checked for multicollinearity among the independent variables by examining the VIF (variance inflated factors). As the VIFs were within the acceptable range, multicollinearity was not a problem in this study. The assumptions of regression analysis were satisfied and as such, the OLS estimation method could be employed to test the hypotheses proposed in this study.

To test the proposed hypotheses, all the dummy control variables, scale control variables, and independent constructs were regressed against each of the dependent variables. Following the suggestions of Cohen et al. (2003) to incorporate dummy or categorical variables in the regression, the different types of manufacturing firms (Motor Vehicles & Transportation, Electronics & Electrical, Chemicals & Petrochemicals, Industrial Equipment, and Food & Beverages) were coded as five different sets of variables and labeled as 'Manufacturing firms: Motor Vehicle & Transportation (MV&T)' and so on. All the manufacturing firms apart from these categories were grouped as ‘Manufacturing firms: Other categories’ and used as the baseline. The responses with the geographical location of the core suppliers mostly located in North America were coded as the variable ‘Location of core suppliers: North America (LCSNA),’ and the responses with a global dispersion of the core suppliers were coded as ‘Location of core suppliers: Global (LCSG)’. The responses that indicated the core suppliers were mostly local were treated as the baseline. The following sets of OLS regressions were estimated for each of the dependent constructs independently:

Model 1: Controls

$$Y_i = \alpha + \underbrace{\text{(Dummy control variables)} + \text{(Scale control variables)}}_{\text{Control variables}}$$

Model 2: Full Model (Including the controls and all proposed independents)

$$Y_i = \alpha + \underbrace{\text{(Dummy control variables)} + \text{(Scale control variables)}}_{\text{Control variables}} + \text{(Independent Constructs)}$$

$$\text{Where: } Y_i = \begin{cases} 1 = \textit{Risk Recognition Ambiguity} \\ 2 = \textit{Impact Recognition Ambiguity} \\ 3 = \textit{Response Recognition Ambiguity} \\ 4 = \textit{Partner Response Ambiguity} \end{cases}$$

(Dummy control variables) = β_1 MV&T + β_2 C&P + β_3 E&E + β_4 F&B + β_5 IE + β_6 LCSNA + β_7 LCSG;

(Scale control variables) = β_8 SALES + β_9 PROC + β_{10} EMP + β_{11} SIZE + β_{12} COM + β_{13} VOL + β_{14} MIX + β_{15} TECH + β_{16} COMPLX;

(Independent variables) = β_{17} REL + β_{18} STR + β_{19} POS

In the first model, I entered all the dummy and the scale control variables. These were followed by the independent variables in the second model. The results are reported in tables 15, 16, 17, and 18, respectively, for each set of dependent constructs. The tables report the standardized as well as unstandardized regressions estimated and the standard error for independent variables and controls. The results also include the R-squared and increments to the R-squared values as compared to the respective base model (model 1) for each dependent variable. The tables also report the incremental F value that indicates the statistical significance of the additional variance explained by the independent variables in the second model. The incremental F value was calculated using the expression presented in Tabachnick and Fidel (2007). Additional discussion of this approach can be found in Wilkinson (1979) and Wilkinson and Dallal (1981).

$$F_{inc} = \frac{(R_{wi}^2 - R_{wo}^2)/m}{(1 - R_{wi}^2)/df_{res}}$$

F_{inc} is the incremental F value; R^2_{wi} is the multiple R^2 for the second model with additional independent variables; R^2_{wo} is the multiple R^2 for the first model; m is the number of independent variables in the second model; and df_{res} = (N – k – 1) where N is the number of observations and k is the number of independent variables in the first model. In addition, m and df_{res} provide the numerator and denominator degrees of freedom for calculating the critical F value.

		Dependent Variable: Risk Recognition Ambiguity					
		Model 1: Controls			Model 2: Full Model		
Variable	Hypothesis	β	*B*	S.E.	β	*b*	S.E.
Controls							
Manufacturing firms: Motor Vehicle & Transportation (MV&T)		.01	.04	.24	-.06	-.15	.22
Manufacturing firms: Chemicals & Petrochemicals (C&P)		-.01	-.03	.26	-.04	-.13	.24
Manufacturing firms: Electronics & Electrical (E&E)		-.03	-.11	.29	-.02	-.06	.27
Manufacturing firms: Food & Beverages (F&B)		-.08	-.32	.30	-.05	-.18	.28
Manufacturing firms: Industrial equipment (IE)		.06	.21	.28	.04	.14	.26
Location of core suppliers: North America (LCSNA)		-.20	-.44	.43	-.17	-.39	.38
Location of core suppliers: Global (LCSG)		-.22	-.49	.42	-.24	-.52	.39
Firm size (Annual sales revenue) (SALES)		-.24	-.25*	.12	-.19	$-.19^{+}$	.12
Firm size (Annual procurement budget) (PROC)		.08	.06	.08	.20	.14*	.08
Firm size (Number of employees) (EMP)		.02	.01	.08	.04	.03	.07
Core supply base size (SIZE)		-.03	-.04	.08	-.06	-.06	.09
Competitive intensity (COM)		-.15	$-.15^{+}$	.09	-.11	-.11	.08
Volume flexibility (VOL)		-.27	-.23**	.07	-.11	-.09	.08
Mix flexibility (MIX)		-.09	-.07	.07	-.15	-.12*	.06
Technological Turbulence (TECH)		-.06	-.05	.07	.02	-.02	.07
Manufacturing complexity (COMPLX)		.04	.03	.07	.16	.14*	.07
Independent variables							
Relational embeddedness (REL)	H1a				-.26	-.27**	.08
Structural embeddedness (STR)	H2a				-.15	$-.12^{+}$	.06
Positional embeddedness (POS)	H3a				-.19	-.17*	.09
Constant			6.67***	.74		7.58***	.67
R^2			.20			.36	
ΔR^2						.16	
F			2.45**			4.62***	
Incremental F						2.08**	
Critical F (at 0.01 level)						2.02	

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Two-tailed test. β refers to standardized regression estimates

b refers to unstandardized regression estimates. S.E. stands for Standard errors.

Table 15: Results of Regression Analysis on Risk Recognition Ambiguity

		Dependent Variable: Impact Recognition Ambiguity					
		Model 1: Controls			Model 2: Full Model		
Variable	Hypothesis	β	*b*	S.E.	β	*b*	S.E.
Controls							
Manufacturing firms: Motor Vehicle & Transportation (MV&T)		-.06	-.19	.27	-.13	-.38	.26
Manufacturing firms: Chemicals & Petrochemicals (C&P)		-.04	-.15	.28	-.05	-.20	.28
Manufacturing firms: Electronics & Electrical (E&E)		-.08	-.28	.32	-.10	-.35	.32
Manufacturing firms: Food & Beverages (F&B)		-.13	-.54	.33	-.09	-.38	.38
Manufacturing firms: Industrial equipment (IE)		.09	.32	.31	.06	.23	.30
Location of core suppliers: North America (LCSNA)		.08	.20	.48	.10	.23	.45
Location of core suppliers: Global (LCSG)		-.02	-.05	.47	-.02	-.03	.45
Firm size (Annual sales revenue) (SALES)		-.24	-.27*	.13	-.19	$-.21^{+}$	.14
Firm size (Annual procurement budget) (PROC)		.04	.04	.09	.14	.11	.09
Firm size (Number of employees) (EMP)		.11	.09	.09	.13	.10	.08
Core supply base size (SIZE)		.02	.07	.10	-.01	-.02	.10
Competitive intensity (COM)		-.11	-.14	.10	-.07	-.08	.09
Volume flexibility (VOL)		-.33	-.30***	.07	-.14	-.13	.09
Mix flexibility (MIX)		-.06	-.04	.07	-.10	-.09	.07
Technological Turbulence (TECH)		-.06	-.05	.08	.02	-.01	.08
Manufacturing complexity (COMPLX)		.08	.07	.08	.18	.17*	.08
Independent variables							
Relational embeddedness (REL)	H1b				-.17	-.19*	.10
Structural embeddedness (STR)	H2b				-.04	-.03	.08
Positional embeddedness (POS)	H3b				-.30	-.31**	.11
Constant			7.38***	.85		7.78***	.83
R^2		.22			.33		
ΔR^2					.11		
F		2.76**			3.97***		
Incremental F					1.37		
Critical F (at 0.1 level)					1.48		

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Two-tailed test. β refers to standardized regression estimates

b refers to unstandardized regression estimates. S.E. stands for Standard errors.

Table 16: Results of Regression Analysis on Impact Recognition Ambiguity

Variable	Hypothesis	Dependent Variable: Response Recognition Ambiguity					
		Model 1: Controls			Model 2: Full model		
		β	*b*	S.E.	β	*b*	S.E.
Controls							
Manufacturing firms: Motor Vehicle & Transportation (MV&T)		-.12	-.34	.24	-.17	-.46	.23
Manufacturing firms: Chemicals & Petrochemicals (C&P)		-.02	-.06	.26	-.02	-.06	.25
Manufacturing firms: Electronics & Electrical (E&E)		-.01	.03	.29	-.02	-.05	.28
Manufacturing firms: Food & Beverages (F&B)		-.08	-.32	.35	-.05	-.16	.32
Manufacturing firms: Industrial equipment (IE)		.03	.12	.27	.01	.03	.26
Location of core suppliers: North America (LCSNA)		.02	.04	.42	.03	.08	.39
Location of core suppliers: Global (LCSG)		.02	.01	.41	.04	.09	.39
Firm size (Annual sales revenue) (SALES)		-.10	-.10	.13	-.05	-.05	.12
Firm size (Annual procurement budget) (PROC)		.03	.02	.08	.11	.09	.08
Firm size (Number of employees) (EMP)		.01	.01	.08	.04	.03	.07
Core supply base size (SIZE)		.07	.07	.09	.03	.03	.08
Competitive intensity (COM)		-.22	-.25**	.08	-.17	-.17*	.08
Volume flexibility (VOL)		-.35	-.30***	.07	-.19	-.16*	.07
Mix flexibility (MIX)		-.16	-.12*	.06	-.18	-.14*	.06
Technological Turbulence (TECH)		.04	.03	.07	.07	.05	.07
Manufacturing complexity (COMPLX)		.06	.05	.07	.13	.11+	.07
Independent variables							
Relational embeddedness (REL)	H1c				-.17	-.20*	.09
Structural embeddedness (STR)	H2c				.10	.08	.07
Positional embeddedness (POS)	H3c				-.32	-.34***	.09
Constant			5.61***	.73		6.01***	.71
R^2			.24			.33	
ΔR^2						.09	
F			3.25***			4.08***	
Incremental F						1.12	
Critical F (at 0.1 level)						1.48	

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Two-tailed test. β refers to standardized regression estimates

b refers to unstandardized regression estimates. S.E. stands for Standard errors.

Table 17: Results of Regression Analysis on Response Recognition Ambiguity

		Dependent Variable: Partner Response Ambiguity					
		Model 1: Controls			Model 2: Full Model		
Variable	Hypothesis	β	*b*	S.E.	β	*b*	S.E.
Controls							
Manufacturing firms: Motor Vehicle & Transportation (MV&T)		-.16	-.48	.27	-.24	-.71	.26
Manufacturing firms: Chemicals & Petrochemicals (C&P)		-.06	-.22	.30	-.08	-.31	.28
Manufacturing firms: Electronics & Electrical (E&E)		-.10	-.37	.33	-.10	-.39	.31
Manufacturing firms: Food & Beverages (F&B)		-.05	-.23	.40	-.02	-.07	.37
Manufacturing firms: Industrial equipment (IE)		.03	.09	.31	.00	.01	.29
Location of core suppliers: North America (LCSNA)		.18	.43	.48	.17	.43	.44
Location of core suppliers: Global (LCSG)		.17	.38	.47	.15	.36	.44
Firm size (Annual sales revenue) (SALES)		-.07	-.08	.15	-.01	-.02	.14
Firm size (Annual procurement budget) (PROC)		-.07	-.06	.09	.05	.04	.08
Firm size (Number of employees) (EMP)		.11	.09	.09	.14	.09	.08
Core supply base size (SIZE)		.05	.07	.10	.03	.03	.10
Competitive intensity (COM)		-.04	-.05	.10	.01	.03	.09
Volume flexibility (VOL)		-.28	-.26**	.08	-.09	-.09	.08
Mix flexibility (MIX)		-.06	-.06	.07	-.12	-.11	.07
Technological Turbulence (TECH)		-.09	-.08	.08	-.05	-.04	.07
Manufacturing complexity (COMPLX)		.06	.05	.08	.18	.17*	.08
Independent variables							
Relational embeddedness (REL)	H1d				-.21	-.23*	.10
Structural embeddedness (STR)	H2d				-.13	-.11	.07
Positional embeddedness (POS)	H3d				-.28	-.29**	.10
Constant			4.96***	.85		5.78***	.81
R^2			.16			.32	
ΔR^2						.15	
F			1.94*			3.90***	
Incremental F						1.96*	
Critical F (at 0.05 level)						1.65	

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Two-tailed test. β refers to standardized regression estimates

b refers to unstandardized regression estimates. S.E. stands for Standard errors.

Table 18: Results of Regression Analysis on Partner Response Ambiguity

4.5.1 Results

H1a to H1d predicted that the degree of relational embeddedness of a focal firm with firms in its supplier network will impact the focal firm's ability to: 1) recognize the impending disruptions in the supply chain (risk recognition ambiguity), 2) predict the significance and magnitude of the disruption (impact recognition ambiguity), 3) respond effectively and efficiently to the disruption (response recognition ambiguity), and 4) be fairly confident about partner firms' response to the disruption (partner response ambiguity). I hypothesized that a greater degree of relational embeddedness of the focal firm in its supplier network will reduce the organizational ambiguity associated with risk recognition, impact recognition, response recognition, and partner response.

The results provide support for all the four hypotheses related to relational embeddedness with varying degree of significance. The results indicate there is statistical significance to the negative relationship between relational embeddedness and risk recognition ambiguity (H1a), with a path coefficient of -0.27 at a 0.01 level of significance (Table 15). The results also show there is a negative relationship (path coefficient = -0.19, $p < 0.05$) between relational embeddedness and impact recognition ambiguity (Table 16), which supports hypothesis H1b. Relational embeddedness has a significant negative relationship with response recognition ambiguity (H1c, Table 17) and partner response ambiguity (H1d, Table 18) with path coefficients of -0.20 ($p < 0.05$) and -0.23 ($p < 0.05$,) respectively.

H2a to H2d posited the influence of the cohesiveness of the focal firm's supplier network, or structural embeddedness, on the focal firm's ability to recognize and deal with nature of the risk, the impact, its response, and the partner firm's response to supply chain disruptions. H2a predicted that a greater degree of structural embeddedness will reduce the ambiguity associated with the risk recognition of supply chain disruptions. This research found a moderately significant negative relationship between structural embeddedness and risk recognition ambiguity with a path coefficient of -0.12 at a 0.1 level of significance (Table 15). The results do not provide support for the hypothesized relationship of structural embeddedness with impact recognition ambiguity and response recognition ambiguity, respectively (H2b and H2c). The impact of structural embeddedness on the ability of the focal firm to have a clear and definite understanding of partners' responses to supply chain disruptions was stated in H2d as: a firm with a high level of structural embeddedness in its network will face low levels of partner response ambiguity. The relationship was insignificant with a path coefficient of -0.11 (Table 18). While the negative path coefficient does validate the nature of relationship between structural embeddedness and partner response ambiguity, the relationship remains non-significant.

My argument regarding the significance of the focal firm's positional embeddedness in relation to risk recognition, impact recognition, response recognition, and partner response (H3a to H3d) was supported at varying significance levels; the negative path coefficients indicate that, as predicted, a higher degree of positional embeddedness will lead to low levels of organizational ambiguity. An analysis of the results confirms that positional embeddedness is negatively related to risk recognition ambiguity (path coefficient = -0.17, $p < 0.05$, table 15), impact recognition ambiguity (path coefficient = -0.31, $p < 0.01$, table 16), response recognition ambiguity (path coefficient = -0.34, $p < 0.001$, table 17), and partner response ambiguity (path coefficient = -0.29, $p < 0.01$, table 18). A summary of the results is presented in Table 19 below.

Hypothesis	Expected impact	Result
H1a: ***Relational Embeddedness → Risk Recognition Ambiguity***	Negative	Supported
H1b: ***Relational Embeddedness → Impact Recognition Ambiguity***	Negative	Supported
H1c: ***Relational Embeddedness → Response Recognition Ambiguity***	Negative	Supported
H1d: ***Relational Embeddedness → Partner Response Ambiguity***	Negative	Supported
H2a: ***Structural Embeddedness → Risk Recognition Ambiguity***	Negative	Supported
H2b: ***Structural Embeddedness → Impact Recognition Ambiguity***	Negative	Not supported
H2c: ***Structural Embeddedness → Response Recognition Ambiguity***	Negative	Not supported
H2d: ***Structural Embeddedness → Partner Response Ambiguity***	Negative	Not supported
H3a: ***Positional Embeddedness → Risk Recognition Ambiguity***	Negative	Supported
H3b: ***Positional Embeddedness → Impact Recognition Ambiguity***	Negative	Supported
H3c: ***Positional Embeddedness → Response Recognition Ambiguity***	Negative	Supported
H3d: ***Positional Embeddedness → Partner Response Ambiguity***	Negative	Supported

Table 19: Summary of Result

4.5.2 Additional Analysis

While linear regression enables the examination of a single equation at a time with multiple independent variables and one dependent variable, structural equation modelling as a powerful multi-variables analytical technique allows the analysis of multiple sets of regression equations simultaneously. As an additional analysis and to further supplement the findings of the linear regression previously described, I estimated the structural model (figure 3) with all independent, dependent, and scale control variables. The structural model provided a moderate fit (Relative chi square = 3.03, GFI = 0.89, IFI = 0.88, CFI = 0.88). The R^2 values for risk recognition ambiguity, impact recognition ambiguity, response recognition ambiguity, and partner response ambiguity are 0.34, 0.29, 0.32, and 0.27, respectively. These values are similar to those extracted from the OLS estimation method. In addition, the path coefficients and their significance levels are also similar to the regression analysis results.

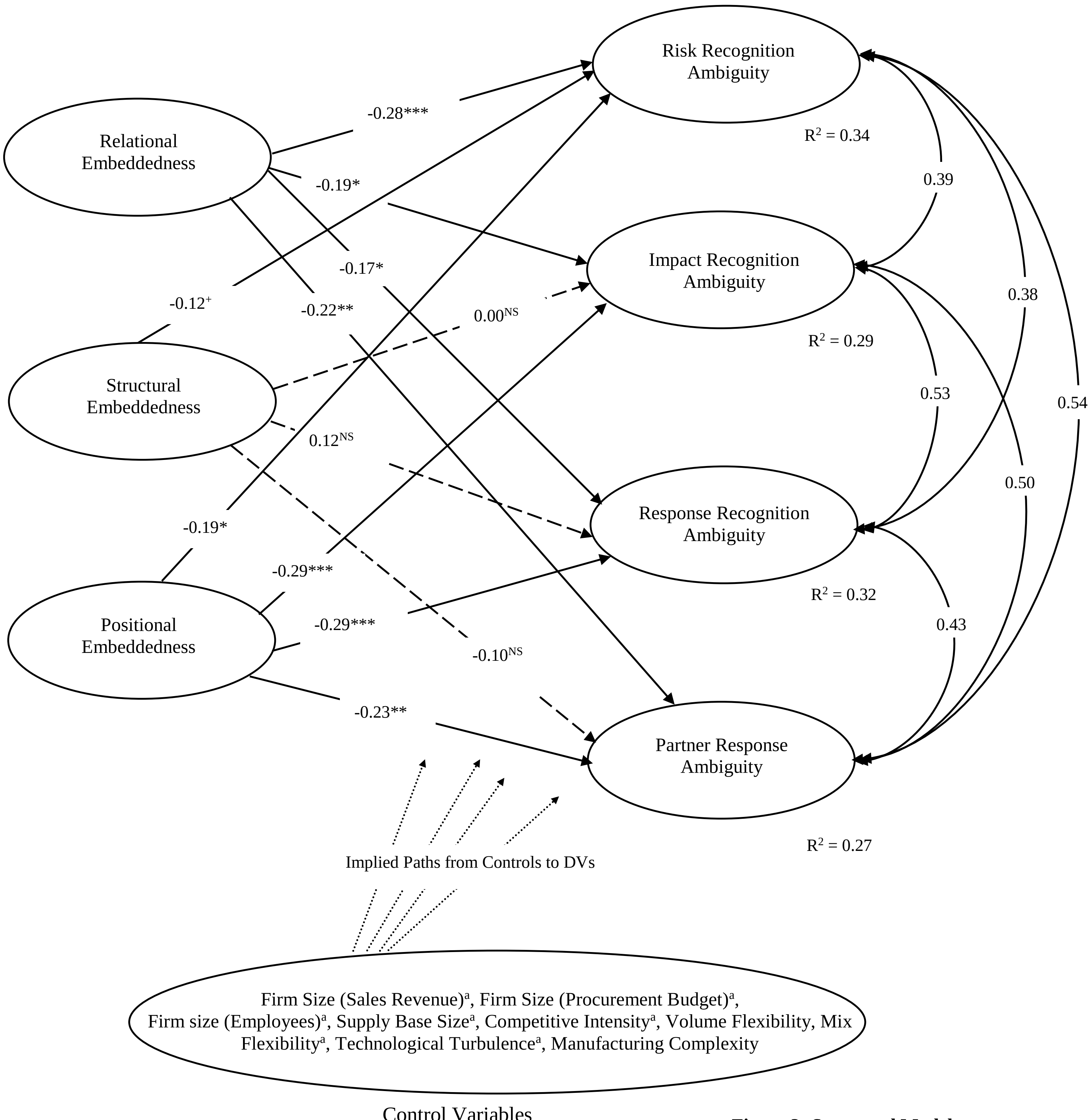

Figure 3: Structural Model

Note: + $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

- Non-significant paths in the model indicated with dashed lines.
- For clarity, control variables are not individually indicated in the model.
- Each of the control variable was modeled with a direct path to all four dependent variables.
- a indicate control variable that has significant path coefficient on at least one dependent variable.

5. Discussion

In this section, I first discuss the results presented in the previous section and explore the implications of the supported and not supported hypotheses. As no study is without its limitations, the next sub-sections states the limitations of this particular study and how these limitations give rise to a need for caution when interpreting the results. Studies such as this are always dependent on practitioners for their valuable input and as one of the aim of this study is to contribute to the managerial practice as well as to the literature, the next sub-section details the managerial and academic contribution s of this research. I conclude the discussion section with a sub-section on the potential for future research related to this study.

With this thesis, I sought to investigate organizational ambiguity in recognizing, assessing, and responding to supply chain disruptions as influenced by a focal firm's supply network embeddedness – relational, structural, and positional. As hypothesized, firms with a high degree of relational and positional embeddedness significantly reduce their risk recognition, impact recognition, response recognition, and partner response ambiguity. This leads to an interesting observation that firms need to co-ordinate and co-operate intensively with their suppliers to reduce ambiguity in recognizing and responding to disruptions.

Scholars have suggested and researched various disruption mitigation measures such as buffering and bridging (Bode et al. 2011), alternate supplier development (Ellis et al., 2010), and postponement and hedging (Manuj and Mentzer, 2009). However, there are two important factors to contemplate while discussing mitigation strategies that are not sufficiently dealt with in the literature. First, a focal firm will initiate disruption mitigation mechanisms once it is certain there is an imminent crisis or it recognizes an ongoing crisis. In supply chains, as most crises evolve beyond the boundaries of the focal firm, the initiation, deployment, and effectiveness of the disruption mitigation mechanism depends on how unambiguously the focal firm is able to read, gauge, and assess the crisis. A firm that enjoys high relational and positional embeddedness in its supply network is shown to be less ambiguous when it comes to assessing and responding to risk. A firm that enjoys strong relational ties with others firms in a supply network will have access to information critical to recognizing and understanding the disruption, which provide the firm with essential input that can allow it to better assess and understand the qualities and significance of the related disruptions. In short, to be able to manage supply chain disruptions successfully, it is essential to be unambiguous in recognizing the incidences and outcomes of disruptions. A firm's relational and positional embeddedness in its supply network helps address this ambiguity.

Second, assuming that the firm is certain and unambiguous regarding the gravity and magnitude of the disruption, its ability to successfully manage the crisis is highly dependent on how effectively and efficiently can it deploy its mitigation strategies. Since a supply chain is a web of firms dependent on each other to produce a final product, more often than not the focal firm will be dependent on its network partners to manage disruptions. For example, a focal firm pursuing a dual sourcing strategy to manage a disruption will be highly dependent on its second supplier to manage the disruption if there are problems with the primary supplier. Hence, the strength of the relationship between the focal firm and its second supplier will essentially determine the effectiveness of the mitigation strategy, an alternate supplier in this case. Also, the positional embeddedness a focal firm commands in the network can influence the second supplier to act in accordance with the expectations of the focal firm. In other words, to be able to manage and mitigate supply chain disruptions successfully, it is essential that the firm be able to unambiguously and precisely recognize, assess, and respond to disruptions. To do this, strong relational and positional embeddedness in its supply network is necessary.

The study did not provide support for a direct relationship between structural embeddedness and organizational ambiguity. I had defined structural embeddedness as the cohesiveness of the relationship between the partner firms in the focal firm's supply network. In hindsight, it is possible that the focal firm does not generally have sufficient knowledge and information about the relationship shared by other firms in its supply network. However, it is not completely unreasonable to postulate that a focal firm would be knowledgeable about its structural embeddedness. Focal firms, especially the manufacturing firms which were the target population for this study, regularly organize vendor meets, joint problem teams from multiple suppliers, and joint R&D and product testing teams with suppliers, for example. In fact, research has shown that Toyota enjoys an advantage over its competitors due to its knowledge sharing network. Toyota's knowledge sharing network is characterized by high interaction and collaboration among the suppliers (Dyer and Nobeoka, 2002). Toyota has demonstrated that it provides the required platform for supplier-supplier interactions. Thus, though no direct relationship was found between structural embeddedness and organizational ambiguity in this study, it is highly unlikely that a focal firm would not be knowledgeable about the structural embeddedness of its supply network.

Another explanation for the lack of a direct relationship between structural embeddedness and organizational ambiguity would be that structural embeddedness operates through relational and positional embeddedness. Consider a case in which a group of suppliers are aware of an alarmingly high labor turnover problem at one of the suppliers that could lead to serious quality issues for the focal firm. The suppliers' high structural embeddedness makes them knowledgeable of this fact; however, will the suppliers' structural embeddedness necessarily translate into information for the focal firm? It is logical to argue that whether or not, or in what form, the information reaches the focal firm depends on the relational and positional embeddedness shared by the focal firm in its supply network. Assuming that the focal firm is not in a position of strong relational and positional embeddedness with any of the suppliers that are knowledgeable of the event, irrespective of the degree of structural embeddedness, the organizational ambiguity for the focal firm will be unaffected.

As previously argued, organizational ambiguity in supply chain risk recognition is a function of information quality and quantity. Specifically, information concerned with disruption received from multiple sources allows the focal firm to reach an understanding of the ongoing event that is precise and complete. However, literature in inter-organizational network cautions that a high level of firm to firm connectedness in the focal firm's network actually undermines the diversity of information shared, thereby, significantly diminishing the information richness and quality. Densely connected firms in the focal firm's network increase information redundancy as likelihood of divergent information reduces significantly (Gnyawali and Madhavan, 2001; Rowley, Behrens, and Krackhardt, 2000). As high level of structural embeddedness does not necessarily improves the availability of diverse and varied information, the organizational ambiguity in supply chain impact and response recognition remains unaffected.

Supplier motivation to act in accordance to the expectation of focal firm in the event of disruption is most likely to be governed by the portion of total supplier business accounted for by the focal firm and the number of other buyer firms that the supplier firm transacts with. In other words, it is possible that the dependence of the supplier firm on the focal firm dictates the extent to which the supplier firm's behavior would confirm to the buyer firm's expectations. As supplier firms cater to business needs of large number of firms higher up in the supply chain, there would be low dependence on any one particular focal firm and its network. Low level of dependence on any one focal firm may motivate the supplier firm to simply be indifferent towards the focal firm in the event of disruption in the focal firm's supply chain. There would be no motivation for the supplier firm to either impede or enhance the focal firm's ability to deal with disruption. The supplier firm would simply be well off diverting its capacity towards the already established business with multiple other firms higher up in the supply chain. It would also imply that the supplier firm would be least worried about the responses from other suppliers in the focal firm's network on account of its unconcerned nature towards the network. Hence, irrespective of extent of supplier-supplier connectedness, the low dependence of the supplier firm on focal firm and its network possibly explains the lack of significant relationship between structural embeddedness and partner response ambiguity.

5.1 Limitations of the Study

Though this study provides a useful perspective for understanding supply chain ambiguity as faced by focal firms, the interpretation of the results in this study should be considered in light of its limitations. This study involves the collection of data from a single respondent in a focal firm. Though the informants were senior level managers with sufficient knowledge to answer the questions asked in the survey, the use of multiple respondents within the firm would have helped triangulate the data among multiple sources and further validated the information.

The data for this study was collected primarily from manufacturing firms with NAICS codes 31 to 33. Diversifying this research to include other major industries such as retail and health care would enable scholars to conduct meaningful comparisons across industries with different types of supply chains. Also, the replication of this research in other industries will increase the generalizability of the results. The low response rate is another limitation of the study. Although the measurement items do not pose any major concern in terms of robustness of the psychometric scale properties such as reliability and validity, the results may be further validated with a large-scale sample size spanning multiple industries.

This research approached the theoretical framework from the focal firm's perspective of its supply network. This approach, though useful because how a firm perceive itself within its network shapes its decision and strategies, would benefit from including more respondents from the focal firm's network. In other words, collecting more information from the other constituents of the network would provide valuable insight into the perceptual differences or similarities shared within the network. As a large-scale data collection from multiple networks might not be feasible due to the requirement of tracking and involving other partners in the network, case studies of selected networks with a focal firm and its group of suppliers would address this issue and offer insights. This study purposefully did not include small-scale firms with annual sales revenue of less than 100 Million. Firms with revenue of less than 100 Million might not command a significant enough supply base to provide appropriate input to the study; however, they could be included as supplier firms to the focal firm in case studies.

5.2 Contribution to Literature and Practice

This research contributes to the literature in multiple ways. This study has distinguished and provided insights into how the attributes of events causing supply chain disruptions are fundamentally different. It is essential to acknowledge, understand, and differentiate supply chain disruptions based on their attributes so as to appropriately gauge and respond to them. In this thesis, it has been observed that there is significant ambiguity in recognizing, assessing the impact, and responding to disruptions that are caused by operational, planning, technological, or design-related failures. In addition, this research also investigated the mechanism of organizational ambiguity and establishes that ambiguity arises due to a limited availability of information and limited information processing capability, which prevents an objective assessment of all possible situational factors associated with a disruption event within a finite time horizon. Owing to organizational ambiguity, it may be extremely difficult to accurately and precisely objectify and translate events in a supply chain to such data driven assessments as magnitude and probability of disruption. Despite the availability of information and knowledge of the events, organizations are highly ambiguous in accurately assessing risk. This scholarship advances a theoretical contribution to organizational supply chain risk assessment and decision making in a highly complex and dynamic supply chain. Bounded rationality and cognitive limitations provide valuable insights into organizational ambiguity in supply chain risk assessment. This research addresses the fundamental characteristics of organizational ambiguity when faced with supply chain risk – irrespective of types of supply chain risk such as supply risk, demand risk, and supplier default risk. This study contributes through its examination of supply networks as a driver of organizational supply chain ambiguity. The literature has often advocated that factors exogenous to the firm drive organizational ambiguity. As supply networks account for an important element of the supply chain environment for a firm, this research contributes to an understanding of how exogenous factors drive organizational ambiguity.

The results from this thesis have several important implications for managerial practice. First, this model of organizational ambiguity, with its focus on recognizing, assessing, and responding to risk, can inform organizational policy on supply chain risk management.

Organizations may improve their supply chain risk assessment and mitigation by encouraging strong co-ordination and collaboration mechanisms in the supply network. This collaboration will serve to reduce ambiguity in recognizing supply chain disruptions and assist organizations in making informed decisions in response to disruptions. Second, our findings suggest that maintaining and implementing a core supplier base may help consolidate and leverage a focal firm's position in the network and thereby reduce organizational ambiguity. The focal firm may command a large group of core suppliers by directly specifying or strongly suggesting the names of tertiary suppliers to its top-tier suppliers. To enjoy a higher position of prominence, the focal firm needs to maintain a close and strong relationship with its suppliers. To develop this effective relationship, it is necessary to have a manageable group of suppliers in the supply base. Third, this study provides useful insights to managers as to what drives the ambiguity in supply chain risk management. By differentiating between the different elements of network embeddedness, managers can understand that both relational ties and network position are paramount to reducing ambiguity. This means that managers should focus on strengthening their firms' relations with the supply network and consolidating its position in the network to reduce the ambiguity they face in dealing with supply chain risks.

5.3 Scope for Future Research

This research can be extended in several additional directions. It establishes that firms are significantly ambiguous in recognizing supply chain risks; however, this finding is not an end point. The next logical extension to this research would be to explore how firms, when faced with ambiguity, manage or devise mitigation strategies ex ante or ex post to disruptions. It would be interesting to study in what form ambiguity manifests itself in supply chain disruption mitigation mechanisms. For example, the inability to be unambiguous in identifying supply chain risk might delay the initiation of mitigation strategies. The time lost due to ambiguity might become the deciding factor in the firm's level of success in dealing with the disruption.

My results provide an insightful revelation that strong embeddedness in a supply network significantly reduces ambiguity. The network acts as a medium of information refinement and provides additional information processing capabilities that help reduce ambiguity. This finding leads to an interesting observation that information technology in its various avatars might play a major role in dealing with supply chain risk ambiguity. For example, the extent to which IT is integrated among the firms in a network will facilitate an efficient exchange of data and information, thereby providing crucial visibility of the events in supply chain. In other words, a continuously available feed from the suppliers regarding the product quality, quantity output, and quantity dispatch would be extremely useful for the focal firm in detecting any anomalies or unusual trends at the earliest moment.

This research provides a framework for understanding supply chain risk ambiguity as it is influenced by supply networks in manufacturing industries. Future research can apply this conceptual framework to various other industries such as retail industry and health care industry. It would be very interesting to compare the results across industries to understand the extent and degree of risk ambiguity in supply chains, and to what extent the supply network impedes or exacerbates ambiguity.

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Appendices

I. Constructs and Items

Please indicate your agreement on a scale of 1-to-7 (1 for 'strongly disagree' & 7 for 'strongly agree') with the following statements that pertain to the core supplier base:

Relational Embeddedness *(Source: Gulati and Gargiulo, 1999)*

a. *We have known most of the suppliers in our core supplier base for a long period of time.* (RE1, *dropped from final analysis*)
b. Our executives often interact with their counterparts in our supplier firms in non-business settings, such as conferences, industry-association meetings, and industry delegations. (RE2)
c. We generally keep our core suppliers abreast of our key future plans independent of any current transactions we have with them. (RE3)
d. We have significant discussions with our core suppliers before undertaking major operational decisions. (RE4)
e. We often help our core suppliers and provide technical and operational assistance beyond contractual requirements. (RE5)

Structural Embeddedness *(Source: Gulati and Gargiulo, 1999)*

a. Our suppliers are encouraged to interact with each other to discuss operational issues (such as scheduling, inventory management, logistics etc.). (SE1)
b. Our suppliers are encouraged to interact with each other to discuss strategic issues (such as process improvement, capacity planning, cost reduction etc.). (SE2)

c. Our suppliers actively co-ordinate with each other while designing and developing new products and processes. (SE3)

d. Our firm views a supplier more favorably if the supplier proactively cooperates, coordinates and participates in joint problem solving with other suppliers. (SE4)

e. Our suppliers regularly organize and participate in vendor meetings to discuss issues faced by them. (SE5)

Positional Embeddedness *(Source: Gulati and Gargiulo, 1999)*

a. Our supply chain policies and practices are often used as benchmarks by other firms within our industry. (PE1)

b. Our firm has the capability to influence key technological and policy developments within our industry. (PE2)

c. For a majority of our key purchasing items we are the leading buyer in our industry. (PE3)

d. Within our industry, views of our firm are well respected and we are often called upon to mediate between other firms in our core supply base. (PE4)

e. We have the reputation for attracting the most competent suppliers within our industry. (PE5)

Please consider a major supply chain disruption to be a significant interruption or stoppage of normal operations due to environmental, operational or geo-political reasons. Please indicate your agreement with the following statements on a scale of 1-to-7 (1 for 'strongly disagree' & 7 for 'strongly agree') any major supply chain disruption/s that your firm might have faced in the past 24 months:

Risk Recognition Ambiguity *(Source: Milliken, 1987; Ashill and Jobber, 2010)*
(All Items for Risk recognition ambiguity below were reverse coded for analysis)

a. We are generally able to correctly anticipate and identify any impending major supply chain disruptions. (RRA1)

b. We are generally able to quickly recognize the potential for internal events to cause major supply chain disruptions. (RRA2)

c. We are generally able to quickly recognize the potential for external/environmental events to cause major supply chain disruptions. (RRA3)

d. Our prior and immediate characterization of the disruptive situations does adequately match the actual characteristics of disruptive events. (RRA4)

Impact Recognition Ambiguity *(Source: Milliken, 1987; Ashill and Jobber, 2010)*

(All Items for Impact recognition ambiguity below were reverse coded for analysis)

a. We are generally able to correctly estimate the magnitude of operational loss (production downtime, loss of capacity etc.) as the consequence of a major supply chain disruption. (IRA1)

b. We are generally able to correctly estimate the magnitude of financial loss as the consequence of a major supply chain disruption. (IRA2)

c. We are generally able to accurately gauge any potential erosion of market share as the consequence of a major supply chain disruption. (IRA3)

d. We are generally able to accurately assess any loss of reputation or brand value as the consequence of a major supply chain disruption. (IRA4)

Response Recognition Ambiguity *(Source: Milliken, 1987; Ashill and Jobber, 2010)*

(All Items for Response recognition ambiguity below were reverse coded for analysis)

a. We are generally able to clearly identify the most appropriate remedial action/s from the available options in the event of a major supply chain disruption. (RSA1)

b. We are generally able to correctly evaluate the efficacy of the remedial actions we take in response to a major supply chain disruption. (RSA2)
c. We are generally able to quickly determine the range of different remedial actions available in the event of a major supply chain disruption. (RSA3)
d. We are generally able to swiftly execute specific remedial action/s in the event of a major supply chain disruption. (RSA4)

Partner Response Ambiguity *(Source: Milliken, 1987; Ashill and Jobber, 2010)*
(All Items for Partner response ambiguity below were reverse coded for analysis)

a. We generally have clear understanding of our suppliers' response strategies in the event of a supply chain disruption. (PRA1)
b. We are generally able to correctly anticipate our suppliers' financial capability to withstand a supply chain disruption. (PRA2)
c. We are generally able to correctly anticipate our suppliers' operational ability to undertake remedial measures in the event of a major supply chain disruption. (PRA3)
d. *We generally expect our suppliers to agree to non-scheduled changes such as changes in production plan, delayed payments etc. in the event of a major supply chain disruption.* (PRA4, *dropped from final analysis*)

Please indicate your agreement, on a scale of 1-to-7, with the following questions related to your industry and how your practices compare to the general standards of your industry:

Volume Flexibility *(Source: Braunscheidel and Suresh, 2009)*

a. We can operate efficiently at different production volumes. (VF1)
b. We can operate profitably at different production volumes. (VF2)

c. We can easily change the production volume of our manufacturing process without significant costs. (VF3)

Mix Flexibility *(Source: Braunscheidel and Suresh, 2009)*

a. We can produce a wide variety of products in our plant(s). (MF1)
b. We can produce different types and categories of products without major changeover. (MF2)
c. We can build different categories and types of products in same plant at same time. (MF3)

Technological Turbulence *(Source: Lee and Johnson, 2010)*

a. The technology in our industry is changing rapidly. (TT1)
b. Rapid technological changes in industry necessitate frequent product modifications. (TT2)
c. The rate at which products and services become outdated in our industry is very high. (TT3)

Competitive Intensity *(Source: Bode et al., 2011)*

a. Any product that we can offer, other firms in our industry can match readily. (CI1)
b. Competition in our industry is cutthroat. (CI2)
c. Winning in this marketplace is a tough battle. (CI3)

Manufacturing Complexity *(Source: Bozarth et al., 2009)*

a. The range of products we manufacture utilizing the same production machinery is greater than the industry standard. (MC1)
b. Our bills of material generally have more layers than the industry standard. (MC2)
c. Our product portfolio has high number of unique components as compared to the industry standard.(MC3)

II. Exploratory Factor Analysis

Variable	Items	1	2	3	4	5	6	7	8	9	10	11	12
Relational Embeddedness	RE1	-.03	.04	-.11	-.05	-.06	.02	-.07	.05	-.42	**.28**	-.12	.12
	RE2	.01	.16	-.06	.18	-.05	-.01	-.08	-.03	-.17	**.46**	.24	.05
	RE3	-.13	.23	-.23	.05	.10	.08	-.03	-.09	-.02	**.81**	.00	-.05
	RE4	-.07	.26	-.10	.20	.09	-.02	-.06	-.02	-.17	**.58**	-.04	.16
	RE5	-.12	.30	-.10	.21	.00	.17	-.06	.19	-.09	**.41**	-.01	.10
Structural Embeddedness	SE1	-.06	**.91**	-.10	.14	.04	.03	-.03	.03	-.03	.07	.00	.03
	SE2	-.01	**.93**	-.02	.14	.06	.03	-.02	.04	-.04	.12	.00	.05
	SE3	.05	**.61**	-.07	.13	.12	.05	-.12	.02	-.01	.29	.05	.16
	SE4	.09	**.57**	-.16	.14	-.02	.06	-.03	-.01	-.05	.06	-.08	.11
	SE5	-.06	**.56**	-.20	.15	.00	-.03	-.04	-.20	-.07	.22	.06	.03
Positional Embeddedness	PE1	-.13	.24	-.22	**.72**	.10	.09	-.09	.02	.02	.18	.13	.08
	PE2	-.13	.26	-.01	**.63**	.25	.23	-.01	-.06	-.07	.06	.04	.07
	PE3	-.17	.19	-.09	**.51**	-.02	.14	-.09	.09	-.09	.14	.26	.16
	PE4	-.07	.16	-.15	**.51**	.06	.07	-.19	.00	-.03	.11	.09	.11
	PE5	-.22	.13	-.10	**.57**	.08	.32	-.09	.04	-.12	.07	-.01	.04
Risk Recognition Ambiguity	RRA1	.15	-.17	**.67**	-.16	-.02	-.15	.10	-.21	.21	-.14	-.05	-.09
	RRA2	.29	-.14	**.67**	-.08	-.06	-.15	.21	-.11	.09	-.13	-.02	.02
	RRA3	.16	-.10	**.59**	-.09	-.02	-.01	.20	-.04	.17	-.27	-.17	.09
	RRA4	.24	-.20	**.61**	-.15	-.15	-.01	.14	.05	.04	-.04	-.11	.09
Impact Recognition Ambiguity	IRA1	.46	-.04	.27	-.13	.00	-.13	**.70**	-.04	.08	-.04	.00	.10
	IRA2	.40	-.02	.22	-.17	.01	-.11	**.76**	.03	.15	-.03	-.09	.05
	IRA3	.20	-.14	.21	-.17	-.19	-.02	**.53**	-.01	.21	-.16	-.10	-.02
	IRA4	.21	-.12	.14	-.10	-.15	-.11	**.54**	-.13	.30	-.09	-.13	-.01
Response Recognition Ambiguity	RSA1	**.87**	.01	.23	-.13	.00	-.13	.18	-.08	.17	-.05	-.09	.04
	RSA2	**.75**	-.01	.22	-.12	-.06	-.10	.24	-.12	.18	-.06	-.15	.00
	RSA3	**.74**	-.01	.18	-.07	.00	-.12	.25	-.10	.06	-.04	-.19	-.04
	RSA4	**.69**	.04	.18	-.24	-.03	-.18	.14	-.11	.11	-.11	-.08	.00
Partner Response Ambiguity	PRA1	.32	-.12	.53	-.17	-.09	-.09	.15	.00	**.52**	-.07	-.04	.00
	PRA2	.20	-.10	.20	-.08	-.08	-.06	.33	-.07	**.77**	-.08	.00	.06
	PRA3	.24	-.17	.47	-.17	-.13	-.13	.17	-.04	**.57**	-.08	-.05	.01
	PRA4	.20	.06	.01	-.08	.05	-.07	.03	-.13	**.28**	-.07	-.06	-.17
Competitive Intensity	CI1	-.08	.02	-.10	.04	.09	-.01	-.06	.03	.15	.02	**.43**	-.14
	CI2	-.09	-.05	-.06	.05	.02	-.04	-.05	-.07	-.08	.02	**.82**	.17
	CI3	-.17	-.01	-.04	.16	.19	-.02	-.05	.05	-.06	.03	**.68**	-.03
Volume Flexibility	VF1	-.26	.06	-.12	.21	.09	**.80**	-.09	.08	-.04	.01	.03	.04
	VF2	-.19	.03	-.07	.18	.10	**.82**	-.08	.13	-.09	.03	-.08	.01
	VF3	-.01	.03	-.07	.13	.12	**.69**	-.05	.24	-.05	.06	-.03	.08

Mix Flexibility	MF1	-.07	.01	-.04	-.02	.09	.06	.01	**.70**	-.06	-.06	.00	.11
	MF2	-.10	-.04	-.04	-.01	.05	.18	-.04	**.70**	-.05	-.04	.00	.15
	MF3	-.10	-.02	-.08	.07	.15	.12	-.04	**.77**	-.04	.08	.01	.02
Technological Turbulence	TT1	-.05	.10	-.08	.03	**.76**	.17	-.07	.18	-.06	.15	.14	.12
	TT2	-.02	.04	-.05	.14	**.88**	.09	-.03	.19	-.01	-.03	.11	.13
	TT3	.02	.01	-.09	.12	**.73**	.06	-.08	.03	.02	.01	.08	.22
Manufacturing Complexity	MC1	-.05	.09	.03	.12	.14	.09	-.07	.23	-.03	.05	.11	**.43**
	MC2	.03	.17	.07	.16	.19	.05	.18	.03	-.06	.02	-.07	**.57**
	MC3	.04	.11	.00	.06	.18	.00	-.01	.15	-.02	.10	-.04	**.88**

Extraction Method: Maximum Likelihood with Varimax rotation

Table 20: Exploratory factor analysis

III. Test for Non-normality

Construct	Relational Embeddedness					Structural Embeddedness				
Items	RE1	RE2	RE3	RE4	RE5	SE1	SE2	SE3	SE4	SE5
Skewness	-.92	-.03	-.48	-.56	-.71	.29	.43	.53	-.50	.43
Std. Error of Skewness	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19
Kurtosis	1.46	-.70	-.07	-.24	.02	-.99	-.90	-.73	-.83	-.83
Std. Error of Kurtosis	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38

Table 21: Skewness & Kurtosis values: Relational and Structural Embeddedness

Constructs	Positional Embeddedness					Risk Recognition Ambiguity				Impact Recognition Ambiguity			
Items	PE1	PE2	PE3	PE4	PE5	RRA1	RRA2	RRA3	RRA4	IRA1	IRA2	IRA3	IRA4
Skewness	-.13	-.41	-.09	-.10	-.51	-.50	-.73	-.26	-.38	-.91	-.76	-.17	-.45
Std. Error of Skewness	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19
Kurtosis	-.68	-.73	-.82	-.83	-.12	-.43	.13	-.55	-.08	.36	.36	-.66	-.63
Std. Error of Kurtosis	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38

Table 22: Skewness & Kurtosis values: Positional Embeddedness, Risk and Impact Recognition Ambiguity

Constructs	Response Recognition Ambiguity				Partner Response Ambiguity				Competitive Intensity		
Items	RSA1	RSA2	RSA3	RSA4	PRA1	PRA2	PRA3	PRA4	CI1	CI2	CI3
Skewness	-.88	-.58	-.96	-.64	-.58	-.56	-.50	-1.07	-.04	-.68	-1.24
Std. Error of Skewness	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19
Kurtosis	.98	.70	1.13	.54	-.08	-.34	-.09	1.04	-.82	.02	2.27
Std. Error of Kurtosis	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38

Table 23: Skewness & Kurtosis values: Response & Partner Recognition Ambiguity, Competitive Intensity

Constructs	Volume Flexibility			Mix Flexibility			Technological Turbulence			Manufacturing complexity		
Items	VF1	VF2	VF3	MF1	MF2	MF3	TT1	TT2	TT3	MC1	MC2	MC3
Skewness	-.53	-.66	-.07	-.81	-.40	-.78	-.22	.02	.52	.00	-.08	-.25
Std. Error of Skewness	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19
Kurtosis	-.41	-.28	-.86	-.04	-.66	-.14	-.67	-.90	-.53	-.34	-1.03	-.78
Std. Error of Kurtosis	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38

Table 24: Skewness & Kurtosis values: Volume & Mix Flexibility, Technological turbulence and Manufacturing complexity